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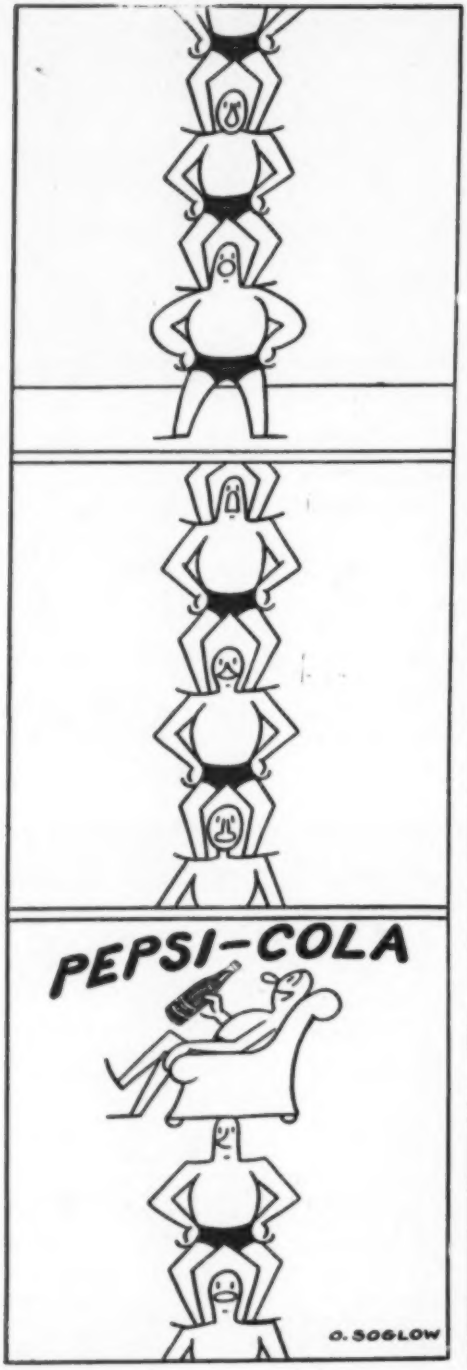

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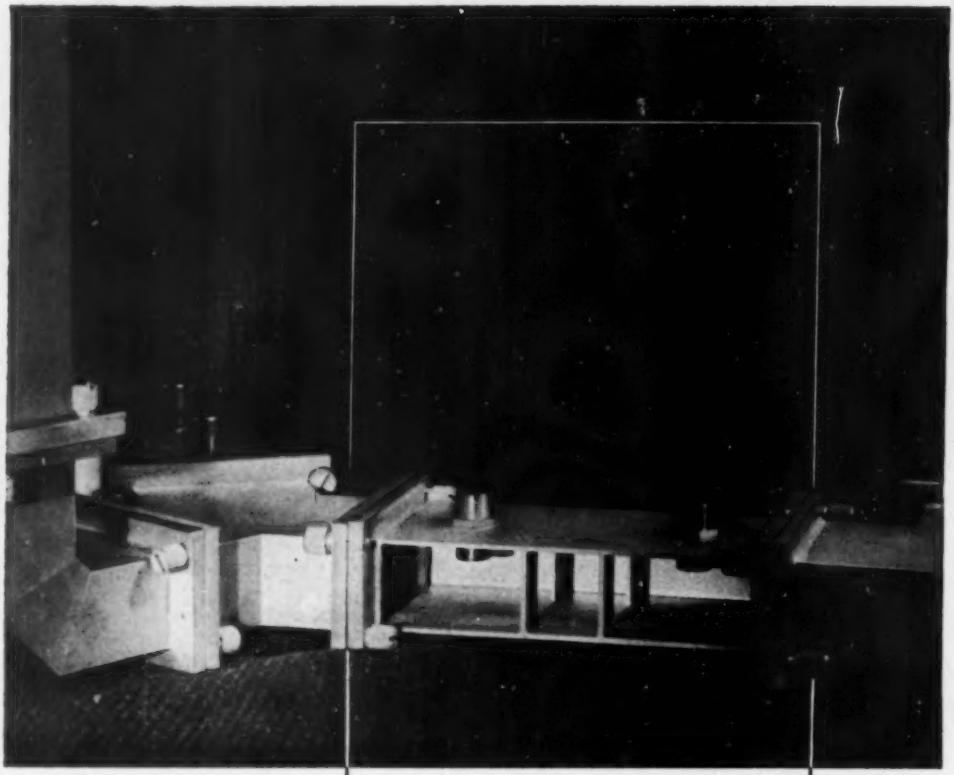

The two filters in the picture (one with side cut away) are used to separate two radio channels coming in on the same antenna but on different frequencies. At the end of the connecting waveguide, the channels are made to part company, each going to a different circuit through its assigned filter.

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Thirty years ago, when all telephone service went by wire, Bell scientists developed means of sending dozens of conversations over the same line.

This they did by giving to each conversation a different *carrier frequency;* then to separate it from the others, they used a device which they had invented and named — the *electric wave filter.*

Today, in microwave telephone systems, the message-bearing waves pass to and from the antenna in pipes called waveguides. So scientists in Bell Laboratories devised a different kind of filter — a filter in a waveguide. This filter is a system of electrically resonant cavities formed by walls and partitions. Waves that set up sympathetic vibrations in the cavities pass through; others are reflected.

In the Bell System, now, single circuits are carrying many conversations at the same time through precision wave-filtering.

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The advanced classes in mass killing take advantage of the simple fact that all great cities have to have water. That water may be a bay, a river, a lake, or a chain of reservoirs. Hit the water with the bomb and you create a cloud of radioactive vapor and liquid which silently devastates a far wider area—and can sift into the air conditioning of the deepest vault, or flow efficiently through the pipes which run to every home, building, and fire hydrant.

Yes, the atomic shower bath is much more deadly: people are living again in the ruins of Hiroshima and Nagasaki; but the ships which lived through the savage spray at Bikini one year ago are still too "hot" to be inhabited. And the Navy has found no way to wash off this deadliest of poisons.

Newest method of extinction contemplates a radioactive cloud produced by nonexplosive shells thrown from aircraft. Hitch this idea to super-rockets like the one described in this issue (page 75) and you should get a concept of terror which makes a mere crater seem like a cup in a putting green.

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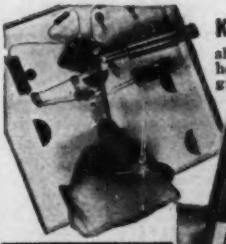

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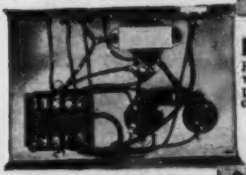

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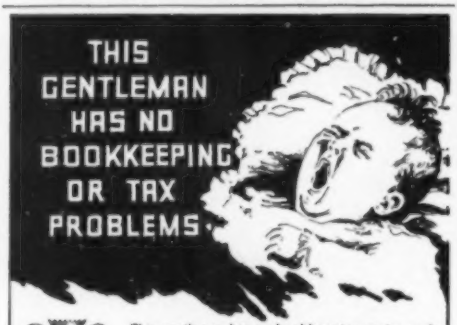

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LETTERS

Chronology Corrected

Sir:

On page 122 of the May issue the following item appears: "... Lockyer, accomplishing the first transmutation of metals, obtained calcium from copper." I should be glad to be advised of the publication on which this is based. I am equally certain that the statement is erroneous and that Lockyer did not accomplish this feat, which has not yet been accomplished. Lockyer's claim, which I have not seen, was not accepted generally, any more than the claims in 1919-1920 that gold had appeared in mercury arc tubes after prolonged operation. The first actual transmutation, nitrogen-14 to oxygen-17, was performed by Rutherford in 1919, 40 years later....

W. F. HOLDEN

Woodside, N. Y.

PSM's researcher slipped up there. Although Lockyer's work in spectrum analysis brought him close to the theoretical possibility of transmutation, Reader Holden is right in insisting that its actual accomplishment belongs to Rutherford.

Sir:

... Your May '47 issue, the 75th Anniversary job, has as a star feature "The Growing Years of Science." Under the year 1941 I find "Electron microscope used successfully after Pearl Harbor raid to locate metal splinters."

But in the *Journal of the American Medical Association*, Feb. 28, 1942 I find an article entitled "Surgical Experience at Pearl Harbor," by Dr. John J. Moorhead. Dr. Moorhead says that he used the gadget on 22 cases at Pearl Harbor and that it consists of an electromagnetic induction apparatus that functions in the manner of a mine detector....

PAUL J. KOPSCH

Baldwin, N. Y.

Dr. Moorhead and Reader Kopsch are

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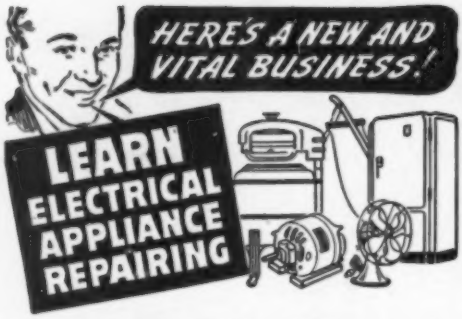

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right. The electron microscope is older than Pearl Harbor and far different from the device used there to locate metal splinters.

Sir:

. . . Under the year 1939, you state that the first controllable-pitch propeller was installed on the P-36 in that year. . . . What about the Lycoming-Smith mechanical propeller used on the Martin B-10? That propeller was a "constant speed" type prop.

LT. LOWELL D. SHARRETT

Tampa, Fla.

The date to which PSM was referring but should have made clear was for the installation of the first four-bladed, controllable-pitch propeller, the adjective "four-bladed" having been lost somewhere along the way from author to printer.

Sir:

. . . You state that the first parachute jump from a plane was made in 1919.

A jump that was claimed to be the first one from a plane occurred in St. Louis, Mo. somewhere around 1912. I was a child at the time, but I saw it.

HAROLD B. DAVIDSON

Little Neck, Ark.

PSM's statement should have been qualified to include the words "official Army." The jump that Reader Davidson saw in 1912 at St. Louis was neither recorded by the Army as official nor made with the type of parachute that later came into use.

The Eyes Have It

Sir:

. . . You describe the (folding) goggles (PSM, May '47, p. 153) as having "a stainless steel rim extending across the top." This is incorrect. Only the telescoping temples . . . are made of stainless steel. The frame across the top is molded plastic.

ROBERT S. BUCKBINDER

The Frederick-Clinton Co., Inc.
New York, N. Y.

In rewriting the information on these goggles for publication, PSM took the more popular use of the term "temples" as designating the parts of the frame across the top of the lenses, rather than the specialized trade application, which limits its use to the fore-parts of the ear pieces.

INVENTORS

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Radio or Blanket Control?

Sir:

I have been reading your magazine almost since I can remember, and I would like to say it's the "tops."

. . . All these years I have been trying to find a mistake without any success. Well, at last I have found one. In your splendid anniversary issue (May) on page 126 (Measurements Unlimited mural) the article No. 51 labeled "radio" is in actuality a Simmons electronic blanket control. If it's a radio, where is the speaker grill, anyway?

HARRY K. TAYLOR

West Palm Beach, Fla.

PSM appreciates Reader Taylor's careful and constant scrutiny, but to him and the many others whose curiosity also prompted them to write in, it can only pass along GE's assurance that its artist intended the disputed article to be a radio, not a blanket control. Frankly, though, the absence of a speaker grill and what appears to be a thermometer leave PSM wondering, too.

Doubting the Demon

Sir:

The article on "Maxwell's Demon" in your 75th Anniversary issue states that a jet of compressed air is forced through the nozzle. Then it is slowed down by the tube's spiral core. Some of the air molecules drop to the center of the tube, pass along heat to the outer air, and stay cool. The air coming in the jet supposedly speeds up and loses heat. All this is well and good, except, if I remember correctly, that a substance takes on heat when it speeds up and gives it off when it slows down. . . . Maybe you can explain it for me. I certainly can't figure it out.

GUERRY C. BROWN

Delray Beach, Fla.

As the article said, air entering the Hilsch tube jet has two pockets full of energy—one heat energy, the other velocity energy. In speeding up, it takes energy from the heat pocket (making it cooler) and puts it into the velocity pocket (making it move faster). The energy for increased speed had to come from some place; it came from the original heat. (But, remember, the physicists are still arguing over just how the Hilsch tube works.)

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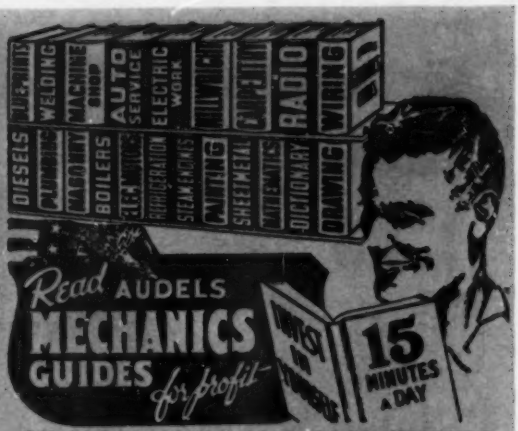

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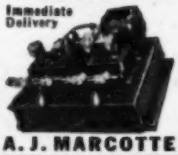

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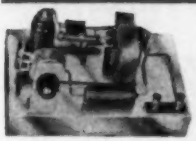

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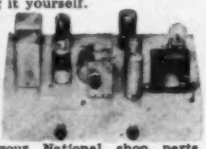

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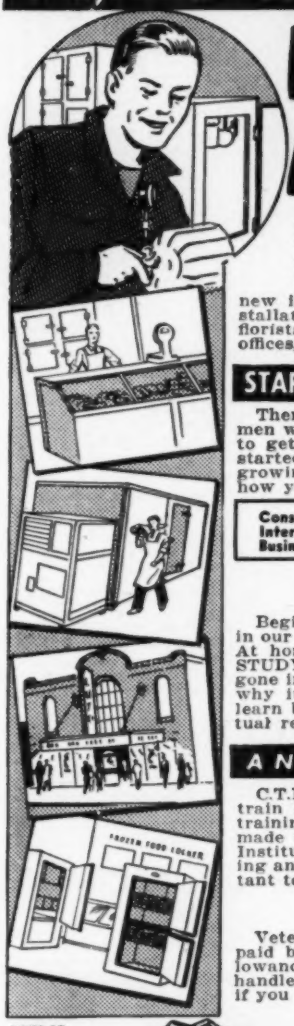

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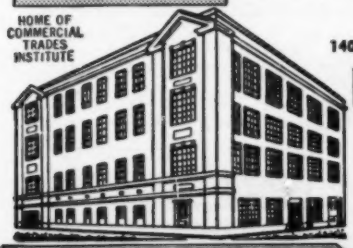

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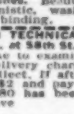

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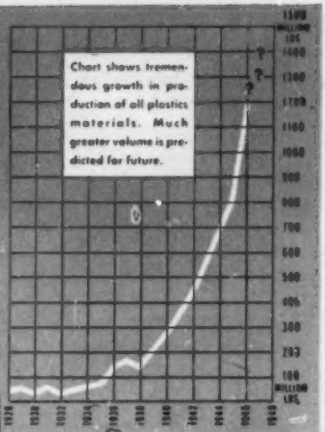

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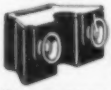

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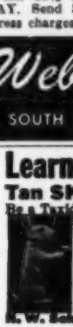

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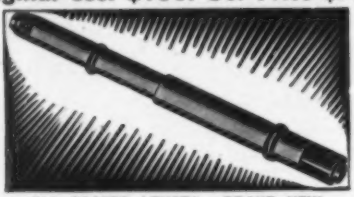

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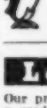

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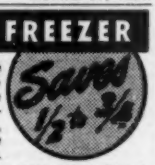

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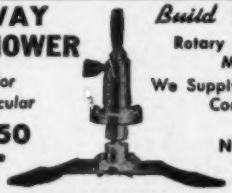

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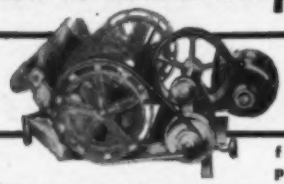

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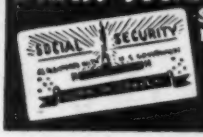

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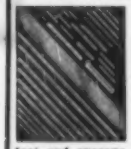

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MUFFLER manual. Convert easily to Hollywood, Laguna, Westwood, duals, etc. Includes construction details, regulations, diagrams. Postpaid $1. Mellotone, Box 723C, Arcadia, Calif.

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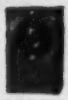

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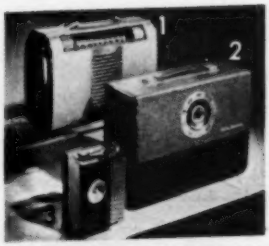

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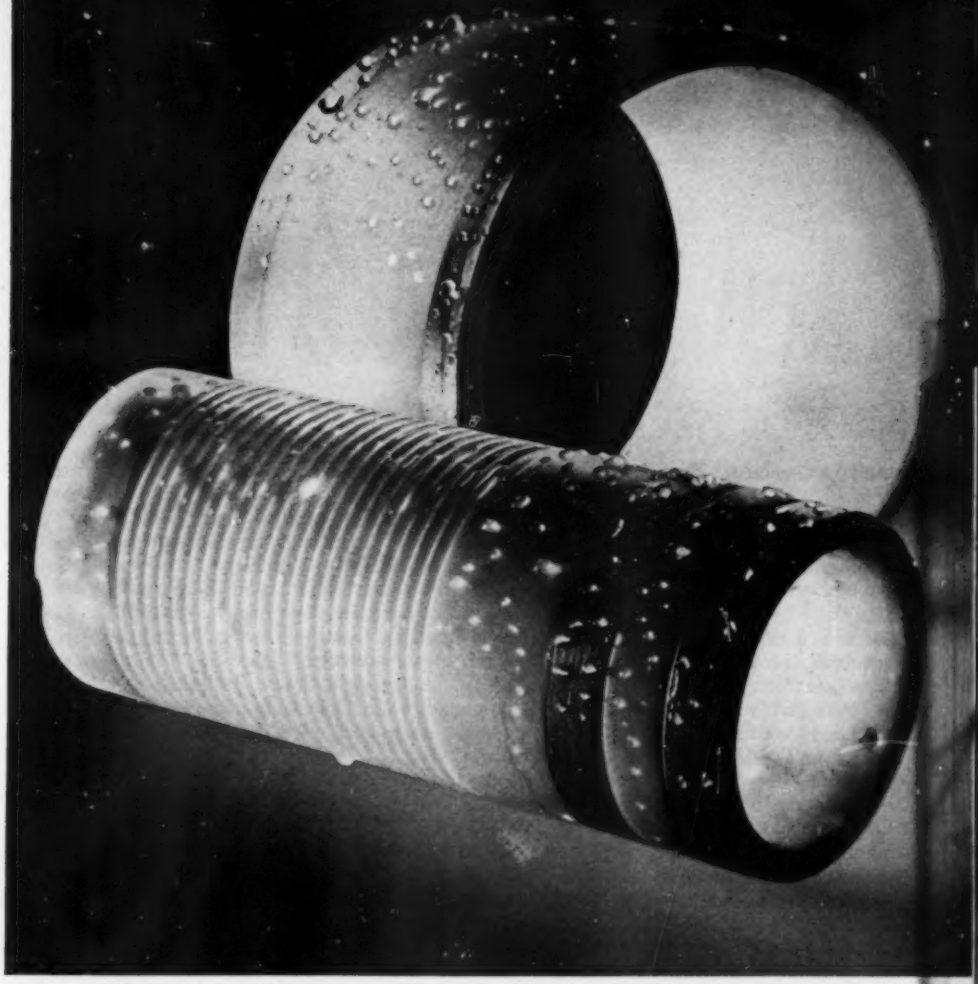

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Our Big Ditch is a dangerous bottleneck in a nervous world; here are three proposed ways to make it safe and efficient.

New Plans for Panama

By Stephen L. Freeland

THE Panama Canal is the most dangerous important waterway in the world today, averaging 50 accidents annually for 20 years —an accident a year for every mile of its length. This record in itself is bad enough to justify doing something about the 40-year-old Ditch. But, these global days, improvement of the Canal is a "must." The Air Age and the untold possibilities of atomic energy have increased, if anything, our dependence on the Navy and salt-water shipping.

Congress, with surprisingly little fanfare, has been alert to the need for a Canal big enough and safe enough for any ship to pass through quickly at any time. Late in 1945 it passed a law calling for a complete review of the entire problem, and last March it sent a special subcommittee to the Isthmus on a tour of inspection. Due for debate before the end of this year, the problem revolves around three possible schemes: the Sea Level plan, the Third Locks project and the Terminal Lake plan.

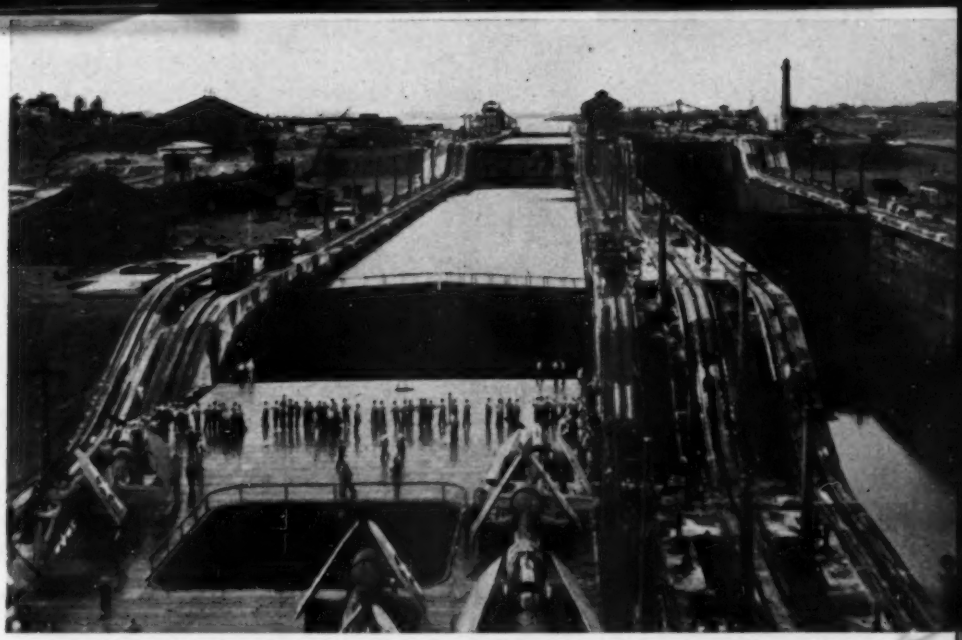
The best way to understand what these three plans mean is to take a trip through the Big Ditch. For the happy tourist, this is a joy ride through exotic scenery. For the engineer, it is a demonstration of one of the world's greatest pieces of hydraulic machinery. But for the pilot, it is a nerve-tingling, spine-chilling duel with disaster from start to finish, with good luck helping good management more times than he would care to count.

A pilot's picture of the Canal varies somewhat with the ship he's handling—from a yacht to a battleship. Perhaps the trickiest are twin-screw vessels with a single rudder amidships. These, in pilot's language, are "cranky," slow to answer the helm. Ore ships and old tankers are notoriously shifty.

They Have to Fit

Our Navy's capital ships are considered "good handlers," but their sheer size is problem enough. Shoving a battlewagon safely into a lock chamber is a little like getting a base drum into a telephone booth on the dead run—it has to be right first try. An *Essex* class carrier, for instance, slides into 110-foot-wide locks with only nine small inches to spare on either side. The little electric locomotives, called "mules," that run along the lock walls can do little but hold lines steady on such big vessels; the ships enter the locks and stop under their own power, guided by the "mules."

The pilot who takes a ship through the Canal from the Pacific to the Caribbean calls it a "northbound transit." He picks up the ship at sea, then guides her along a straight,



U.S.S. Bunker Hill has only inches to spare in the first of Gatun Locks. Bigger *Midway* class carriers are too big to squeeze through, have to make an 8,000-mile detour around the Horn.

narrow channel into Balboa Harbor. Here, if it is night during the rainy season, he probably has to wait. Fog in Gaillard Cut, so thick he can't see the fo'c'sle from the wheelhouse, is the usual occurrence—rolling in sometime after 9 p.m., clearing off about 8:30 a.m. about 110 nights a year.

In the dry season, however, he may be permitted to take his ship right on through. Passing out of Balboa Harbor, he enters another narrow channel between low, hummocky hills and steams toward Miraflores Locks. Before he ever gets there he notices a difference in the way his ship reacts; she gets slower and slower in answering the helm as the water gradually gets shallower until it reaches 45 feet, which is the Canal's controlling depth.

Miraflores Locks are his first real hurdle—a jump of 54 feet in two steps. Remembering that one in three of the Canal's accidents happens at the locks, he approaches cautiously. But he can't be too cautious, because he has to keep steerageway. If the ship is not moving fast enough to make the rudder bite the water, a gust of wind or the tidal current can take command and smash his ship against the lock wing.

The Ditch's Bottleneck

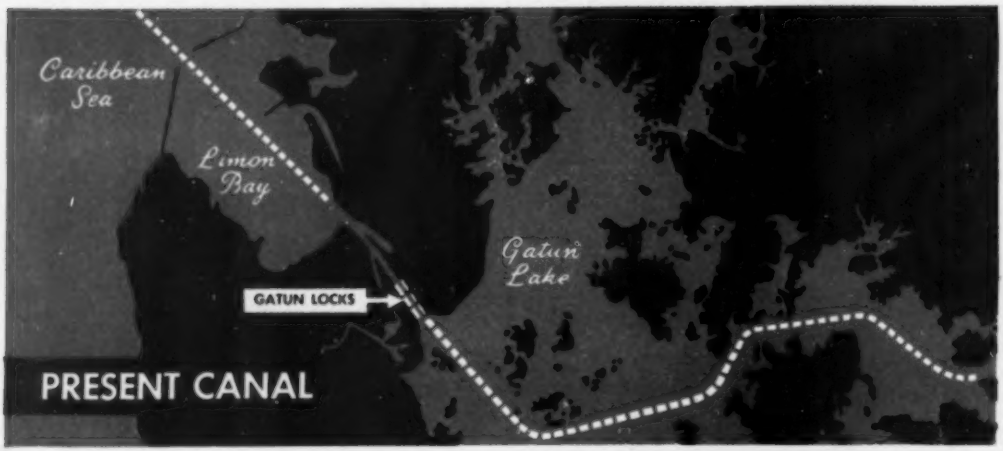
Safely through the first set of locks, the pilot crosses Miraflores Lake, a mile-wide marsh with a channel through it, and comes to Pedro Miguel, the bottleneck of the Canal. One set of locks (1,000 feet long, 110 feet wide and 45 feet deep at the sills—the present standard size for the Canal) waits to raise him another 31 feet to summit level.

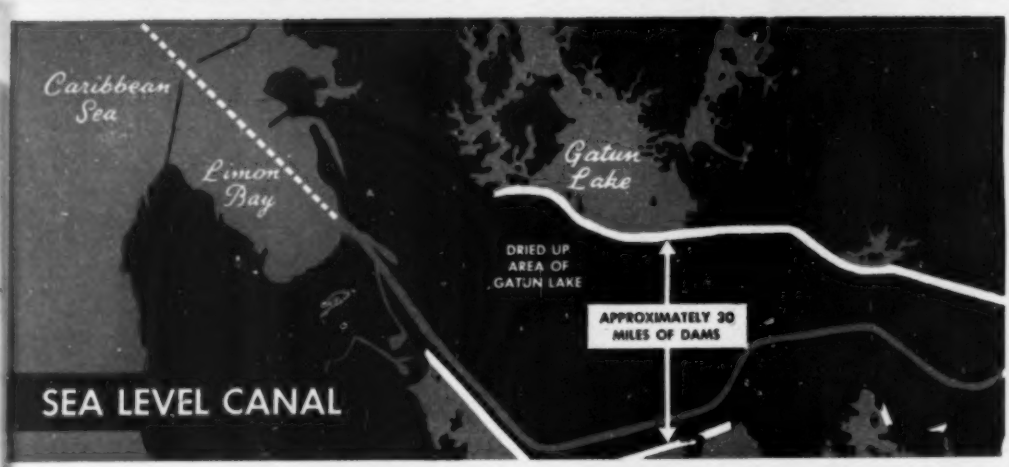
Here the pilot is confronted with more unhappy memories. He can recall how ships suddenly went aground, although both lead line and chart showed plenty of water. The entrance to the locks had silted up, and the lead had simply sunk into the ooze. The problem has been fairly well licked now by huge suction dredges, but still there is no safe place for a ship to wait.

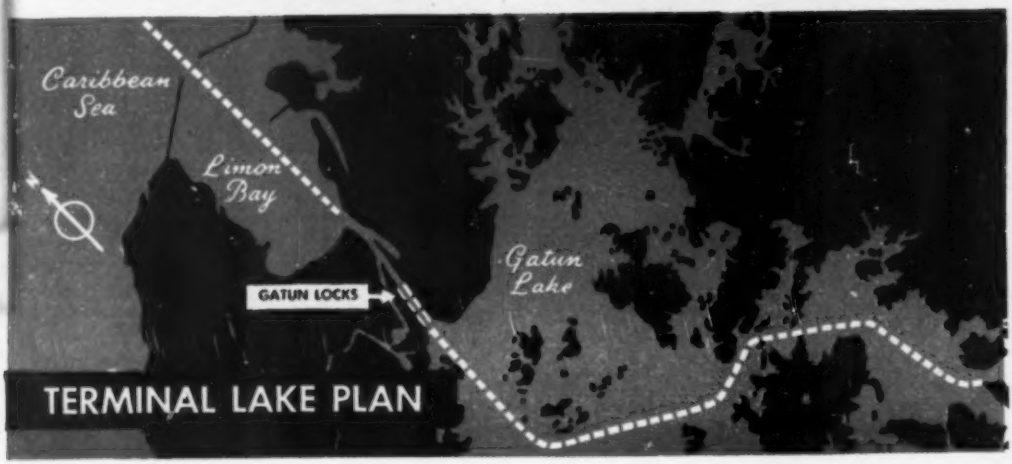
Compound Hazards

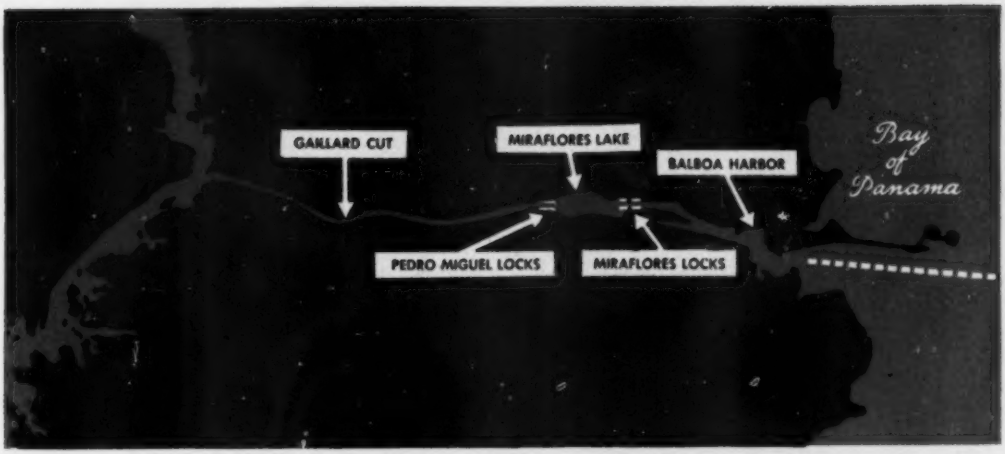
Beyond Pedro Miguel, the pilot takes his ship into the nastiest stretch of water in the whole transit, the famous Gaillard (formerly Culebra) Cut—seven miles of cold danger knifing through the Continental Divide. He can see plenty of reminders of accidents, and he recalls statistics: Out of 50 recorded collisions in the Big Ditch, 26 happened along here, as did 54 of 110 accidents caused by steering-gear failure. Twenty-one out of 70 groundings took place in the Cut, and nine of them resulted in sinkings as compared to four elsewhere.

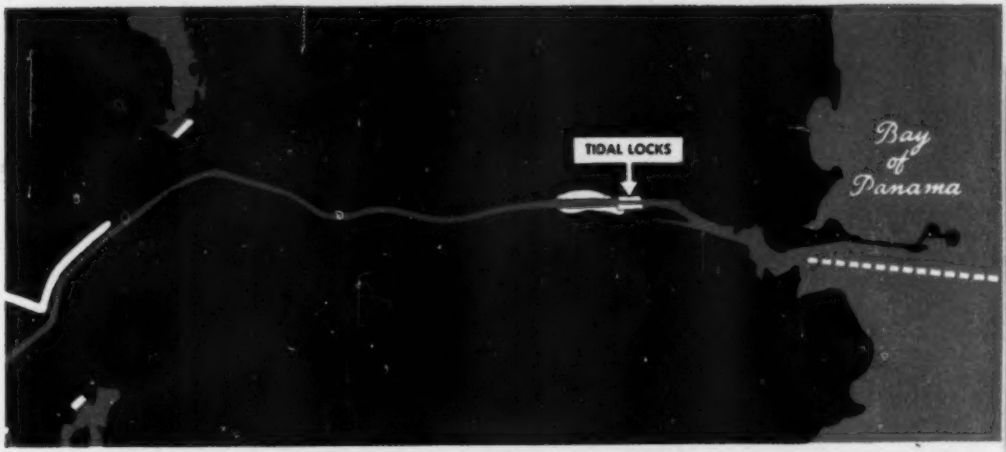
Three factors combine to make the Cut dangerous: It is narrow—300 feet wide at the toe of the slope; it is restricted, so dis-

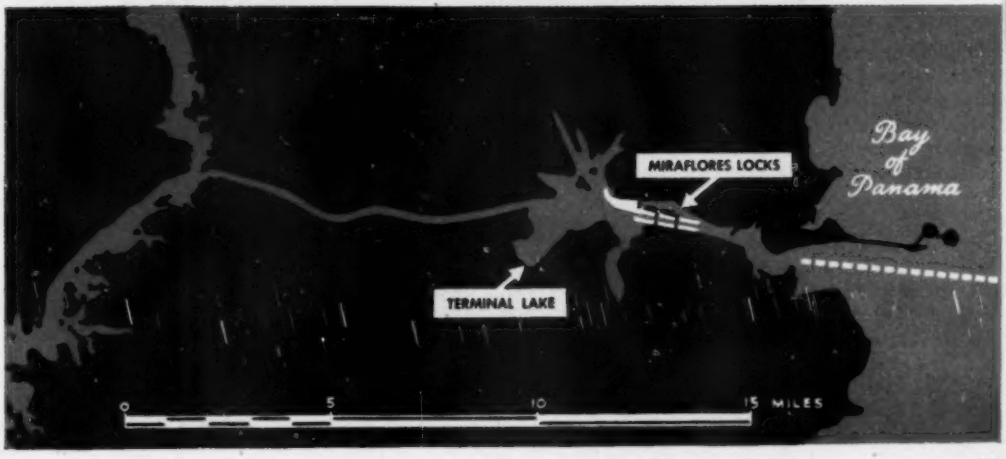

Caribbean Sea
Limon Bay
Gatun Lake
GATUN LOCKS
PRESENT CANAL


Caribbean Sea
Limon Bay
Gatun Lake
DRIED UP AREA OF GATUN LAKE
APPROXIMATELY 30 MILES OF DAMS
SEA LEVEL CANAL


Caribbean Sea
Limon Bay
Gatun Lake
GATUN LOCKS
TERMINAL LAKE PLAN


GAILLARD CUT
MIRAFLORES LAKE
BALBOA HARBOR
Bay of Panama
PEDRO MIGUEL LOCKS
MIRAFLORES LOCKS


TIDAL LOCKS
Bay of Panama


MIRAFLORES LOCKS
Bay of Panama
TERMINAL LAKE
0
5
10
15 MILES

Miraflores Locks are a glove-tight fit for the *U.S.S. Missouri*. The slightest miscalculation can jam a battleship in a lock like a broken cork, tying up traffic until it's pried loose.

placed water can't spread out; and its sides are steep—10 feet vertical to one horizontal. Put together, these three conditions mean that whenever a ship starts to yaw, or swing off course, her stern is liable to be drawn toward the near bank by what the pilots call "bank suction."

And there's plenty of reason for yawing in the Cut. Every time the Pedro Miguel Locks draw water, a three-foot wall of water is sent boring through the Cut at 36.4 feet per second—almost 25 miles an hour.

Going Gets Easier

Out of the Cut at last, the pilot dares to relax a little as he enters Gatun Lake through Gamboa Reach. Here, although the water may drop to a mere 42-foot depth during the dry season, at least bank suction is lessened because the banks themselves are lower and the water has a chance to spread out. Furthermore, the bottom is soft mud. The lake itself is 168 square miles, dotted with tiny islands full of bright tropical birds. The channel through it is almost 24 miles long, ending up at a broad anchorage leading to Gatun Locks.

The Locks themselves let a ship down from the summit level in a continuous three-step operation. From the bottom there is a run of almost seven miles across Limon Bay past Cristobal and Colon out into the Caribbean, where the pilot turns the ship over to its captain again.

All the plans for improving the Canal take the pilot's problems into account, though they solve them in different ways. All of them incorporate, of necessity, some of the same ideas, and all have their merits and their disadvantages.

The oldest plan calls for a sea-level waterway. It would be far from simple or easy to build. The best guess is that it would cost between $1,121,000,000 and $1,310,000,000, and would take from 12 to 20 years to complete. After that, however, it could probably be widened and deepened as we chose without too much trouble.

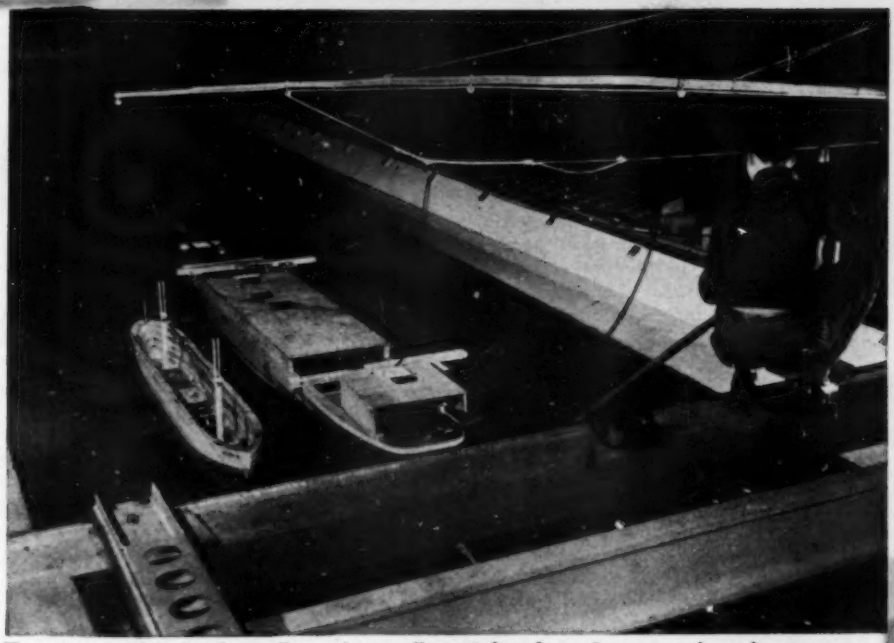
Two Schemes Proposed

Two methods have been proposed for the actual creation of such a canal: the step-down and the deep-dredging plans. In the former scheme, widening and deepening would take place in four successive cuts, working 30 to 40 feet down and as many feet out from the center line as necessary to make the proper slope, leaving most of the present channel in operation.

So far as mere earth moving is concerned, this could be done with existing tools and techniques, but there are two important additional considerations: the present locks and flood control. The plan calls for the removal of the Pedro Miguel and upper Gatun Locks as soon as the first 30-foot cut is complete. After the second cut, the middle locks at Gatun and the top locks at Miraflores would go. These demolitions would tie up the Canal, so temporary locks paralleling existing installations are proposed, to be abandoned when the work is done.

Bombs Get Consideration

The flood-control proposal is even more ambitious. Gatun Lake would be drained and kept that way. This would call for approximately 30 miles of huge barrier dams, "of sufficient proportions to withstand bombing," to contain the waters of the Chagres and Gatun Rivers and their tributaries. These dams and some 25 miles of diversion channels and tunnels would have to be virtually complete before Gatun Lake started to dry up, or there wouldn't be enough water left for lockages, since every chamber uses 30,000,000 gallons per lockage. Once completed, though, they would be good in-



Tests in model basin show effects of a canal's depth and width. In a 300-foot-wide canal 45 feet deep, a ship's rudder has to turn twice as far as it would to get the same result in water 60 feet deep. In narrow channels, pressure can build up between the bow of a yawing ship and the banks; reaction, called "bank suction," can pull stern sideways, ram it against the shore.

surance against two great natural threats to the Canal—flood and drought.

Deep dredging, as the name implies, calls for digging the sea-level canal to grade in one operation from the present summit level. This method would eliminate the need for alternate locks and prior construction of flood-control works. It would, however, call for an awful lot of water to fill the enormously enlarged channel. It would also call for tools that have never been built, though they are not impossible: dredges that could sink spuds and operate buckets under 135 feet of water, for instance.

Champions of the sea-level canal claim that by eliminating the present locks they would eliminate major bottlenecks and major sources of accidents, speed transit time, improve flood control and create a far less vulnerable waterway.

A Second Canal

It was the question of vulnerability that led to the only scheme for comprehensive modernization to earn official approval from Congress—the Third Locks project. This plan called for single-chamber locks 1,200 feet long, 140 feet wide and 45 feet deep, paralleling present locks but at some distance from them. New channels to and from all locks were visualized. In short, except for a portion of the existing channel in Gatun Lake, the Third Locks project when completed would have been a second canal using the same water as the first.

Abandoned in 1942

The three main advantages are obvious: dispersion of critical facilities for security against attack, accommodation for larger ships, and comparatively low cost—$277,000,000. Authorized in 1939 and abandoned because of the war in 1942, the project left a legacy of completed surveys and some excavation (at Miraflores) for new large locks, which can be used in completing work on either of the other two plans.

Both Sea Level and Third Locks plans sound sensible, but ship owners, operators, masters and pilots see plenty wrong with them. If you drop the level of the Canal 85 feet, they point out, you make a restricted waterway out of the entire channel between Miraflores and Gatun—31 miles of Gaillard Cut instead of the present seven. And there would be 12 dangerous bends of 20° or more instead of the two now in the comparatively easy reaches of Gatun Lake. In addition, they maintain that the whole Canal would be tied up in the event of fog in

Gaillard because ships would have no place to wait except in harbors at either end of the Canal.

The Third Locks project, maritime interests say, would only add a new Gaillard Cut, with three extreme turns in it, in the Pedro Miguel by-pass. Lockage surges, too, they say, would be intensified at the point where the cut-off joined the old channel.

Anchorage for Pacific End

The people who use the Canal have their own plan—a lock canal with a summit-level anchorage at the Pacific end to match Gatun on the Atlantic side.

To get this, they would first build a three-stage lock at Miraflores. Then they would build a dam where the present locks are and a series of retaining dikes around Miraflores Lake to raise the level of the lake to 85 feet—summit level. Then they would get rid of the Pedro Miguel Locks. Having accomplished that, they feel, most of the ship-handling hazards of the present Canal would be eliminated.

The Gaillard Cut would lose most of its terrors if ships could steam right through it to safe anchorage on the other side. The anchorage itself, after dredging, would accommodate nine ships in 300-yard berths, 30 in 200-yard berths, which is more than 12 hours' traffic capacity for the Canal. This in turn would simplify control, since ships could come up to summit level at any time instead of having to wait below Miraflores, as is the case now, when there is fog in the Cut.

One feature of the Terminal Lake plan which particularly appeals to pilots is that, with the removal of Pedro Miguel Locks and the surges they create in the Cut, the summit level channel would be completely currentless. All necessary water would be delivered to the two terminal lakes, where the force of its arrival would be absorbed. The entire job probably could be completed in five years for $500,000,000.

To the charge that the Terminal Lake Canal would still be a vulnerable affair of concentrated locks, its proponents reply that after Hiroshima and Nagasaki it is futile to talk of invulnerable structures; after Bikini, it is impossible to call any body of water protected.

Still a Three-Way Choice

Even if the proposed canals *are* alike in vulnerability, there is enough difference among the plans to make the choice difficult. Right now the pick seems to be between the Sea Level and Terminal Lake ideas, but the world is not so peaceful and the fortunes of war are not so certain that we can forget all about the need for a canal that provides alternate locks.

So the future of the Big Ditch remains a three-way choice—with the time for decision almost at hand. END

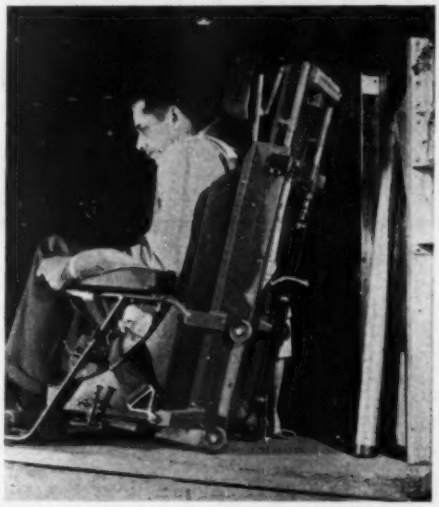
Looking out, through a transparent mirror developed by Libbey-Owens Ford, housewife can see who's there.

Looking in, the caller sees only his own reflection, does not know he is being looked over, cannot talk his way in.

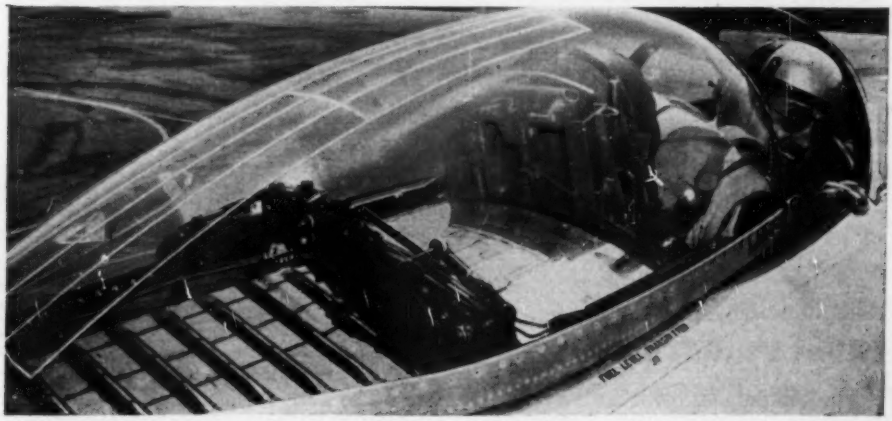
Improved wing-tip fuel tanks and increased firepower are features of the new Shooting Star.

Faster "Star" Totes Six Guns

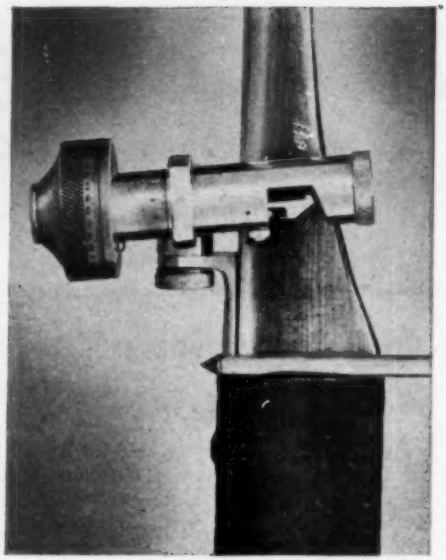
THE new edition of the AAF's jet-propelled Shooting Star, the P-80B, is a faster, tougher, and more formidable fighter. Its six guns, mounted in the nose, capable of firing 1,200 rounds a minute, have proved their accuracy at high speeds. Water injection has been adapted to the J-33 turbo-jet engine to increase power for take-off and climb. Stainless steel has been added around the engine for fireproofing. The skin is thicker; the bulkheads stronger; there is a sturdier base for the heavy armament. To make the pilot happy, the cabin is refrigerated against the friction heat developed at 600 m.p.h. and has an ejector seat for emergencies. In general appearance and dimensions, however, the latest of Lockheed's Shooting Stars is similar to its P-80 predecessor despite the improvements.



Ejector seat enables the pilot to shoot himself clear of the airplane. Ejecting force is a reduced charge in a 37-mm. shell.



Radio antennas are cemented against inside of plastic canopy. Exposed masts on earlier P-80 created drag at high speeds. Another improvement is a simplified instrument panel.

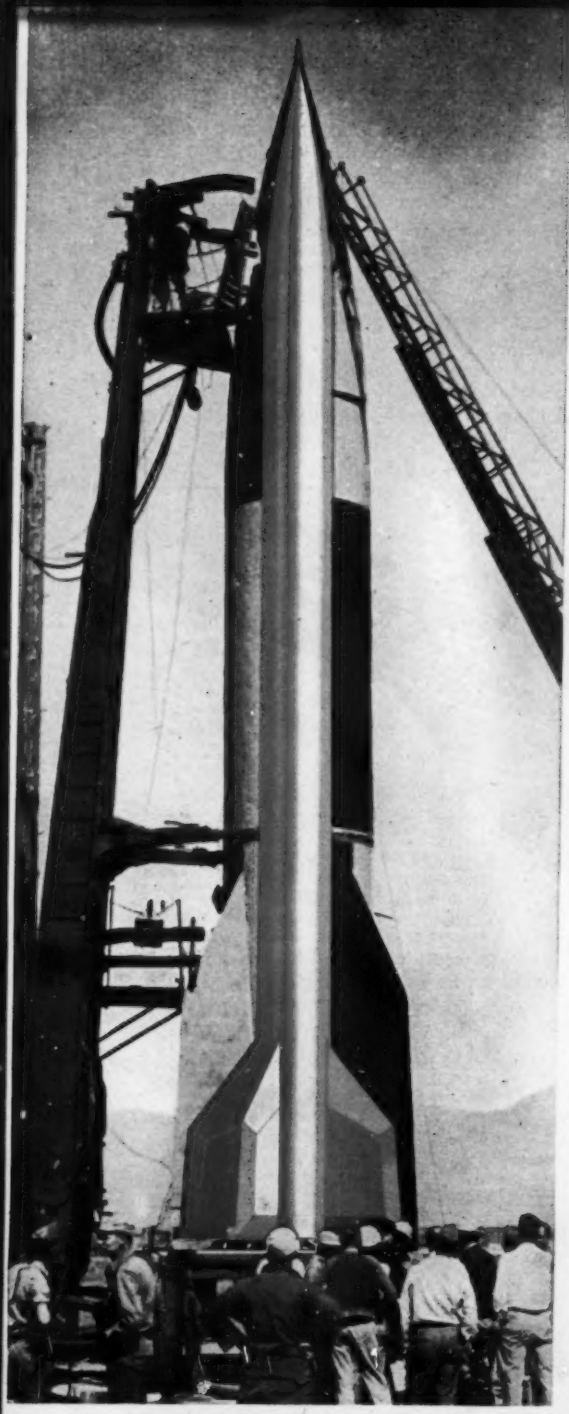


New Sight Aids Archers

MODERN optics is helping archers to double their scores. A new aluminum sight invented by G. T. Bradley, of Los Angeles, can be set to allow for distance and windage. A prism is moved from side to side to shift the target image to compensate for wind drift; another prism is swung up or down to allow for the elevation required by the range. At the same time a mirror reflects the arrowhead up into the sight. When it is lined up in a V, with dashes and a dot on interval elements of the sight, the archer knows his bow is properly aligned and the arrow drawn back the right distance. Allowance can be made for varying reaches and arrow lengths.

Giant Plow Tames Range

YOU can do your plowing on a wholesale basis with this new 60-foot disk plow. It turns over a strip 42 feet wide and can plow 14 acres an hour. Invented by Monroe Terrell, of Dumas, Tex., and T. W. Emerson, of Etter, Tex., the plow has been used successfully on a wheat ranch near Wild Horse, Cheyenne County, Colo.



Neptune's silhouette is shown here against the plump bulk of a V-2 in its launching rack. The Neptune's hull is only two feet eight inches in diameter; V-2 is five feet six inches thick.

1948 Rocket Will Double V-2's Record

Neptune, now being built for the Navy to outdo Nazis' lumbering weapon, is designed to reach 237-mile altitude.

SEVEN months from now, the U. S. Navy will have a rocket so much better designed than the V-2 that it will be able to soar more than twice as high. It will be slimmer than the sleekest fighter plane's fuselage. It will be able to take off from a battleship. It will carry up to a ton of pay load—either delicate, space-exploring instruments or explosives.

This rocket has been named Neptune, after a planet that was not discovered until mathematicians told astronomers where to look for it. The performance of Neptune, the rocket, has been predicted similarly, by mathematics. Ten Neptune rockets are being built now by the Glenn L. Martin Co., of Middle River, Md., for the Navy to test next year. They will cost $1,850,000.

Both inside and out, the Neptune will be a simpler, smoother missile than the mighty but clumsy V-2. Even when fully loaded with 2,000 lb. of instruments—or explosives—it will weigh only two-fifths as much as one of those primitive Nazi dinosaurs. With a 500-lb. cargo, ample for much of the research contemplated in the darkness above the aurora borealis, it will be less than a third as heavy as a V-2.

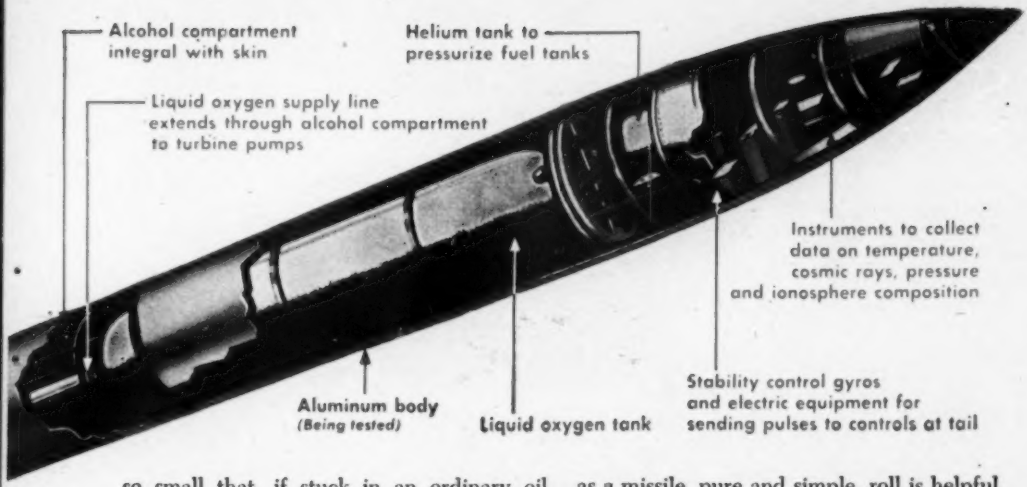
The fins of the V-2 are subsonic airfoils; those of the Neptune will be supersonic. They will be wedge-shaped to help it lunge

through comparatively dense air during the first 10 or 15 miles of an ascent. When lightly loaded for scientific survey trips, the Neptune will start out faster and its top speed will be much greater than that of its deadly predecessors, which hit their wartime targets in England before they could be heard coming.

The V-2s were guided by vanes that extended into the jet stream. These were deflected to change the rocket's course. The Neptune will have no such cumbersome rudder; direction will be determined by the tilt of the engine. Gyros in the nose will sense any deviation from the proper course and send electrical orders to the tail, where obedient machinery will swing the engine enough to change the angle of its blast and thus put the rocket back into an invisible groove. By eliminating vanes, the designers have not only reduced the rocket's weight by 275 pounds, but have also made certain that its exhaust stream will provide more power.

The Neptune's engine is being built by Reaction Motors, Inc., of Dover, N. J., the makers of the rocket engine in the Bell XS-1 supersonic research plane. It will be

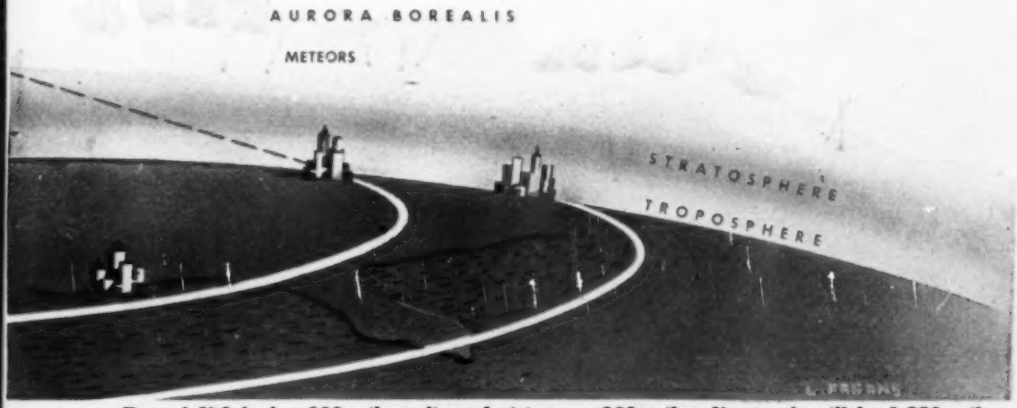
Drawings illustrate Neptune's construction and field of vision compared to V-2 (white circles).



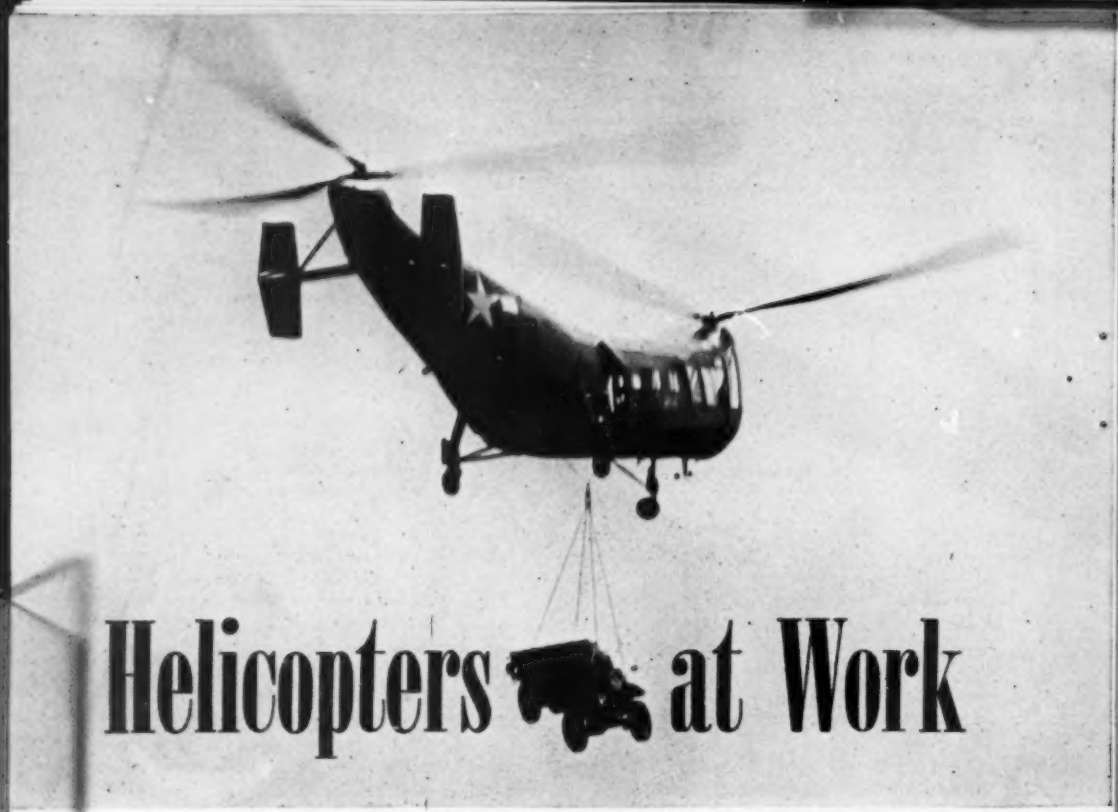
so small that, if stuck in an ordinary oil drum, it would protrude from the end less than a foot. It will weigh 250 lb., about the same as a light motorcycle, yet it will produce 20,000 lb. of thrust. This is less than half the thrust from a V-2 engine but, whereas the V-2 shoots its wad in 67 seconds, the Neptune engine will go on shoving for 75 seconds.

Steam jets will spurt from the Neptune's sides to prevent excessive roll. These will be powered from the exhaust of the hydrogen-peroxide turbine. Normally, the jets will be equal, but if the rocket starts to roll, a valve will increase the jet on the side opposing the roll. No plans for steering the Neptune by radio have been revealed. But the installation of this roll-control apparatus indicates that plans for guiding it are probably being studied. When a rocket is used as a missile, pure and simple, roll is helpful, as it is in a bullet. But in a radio-controlled or guided missile, roll is troublesome, because as the rocket turns, its elevators become rudders and the rudders become elevators.

As a platform for instruments to note the characteristics of the upper atmosphere, the Neptune will be vastly superior to the big German rockets now being used at White Sands. It will be less fussy, for example, about cargo. Whereas a V-2 is limited to useful loads of from 1,700 to 2,600 lb., the Neptune will take anywhere from 100 to 2,000 lb.—and the lighter the load, the higher it will go. The V-2's altitude record is 114 miles; the Neptune is expected to soar 237 miles. And, as Glenn Martin put it, "If it can go that high, figure out what it would do on an incline." END



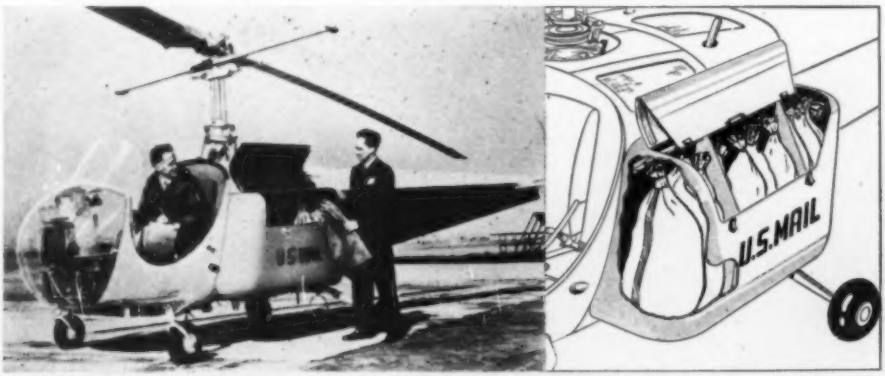
Record V-2 had a 900-mile radius of vision; at 200 miles, Neptune's will be 1,280 miles.



Helicopters at Work

Doing its stuff in the weight-lifting class, this transport helicopter lifts jeep weighing 2,400 pounds. A Piasecki Rescuer (XHRP-1), it can travel 100 m.p.h. when it is not showing off.

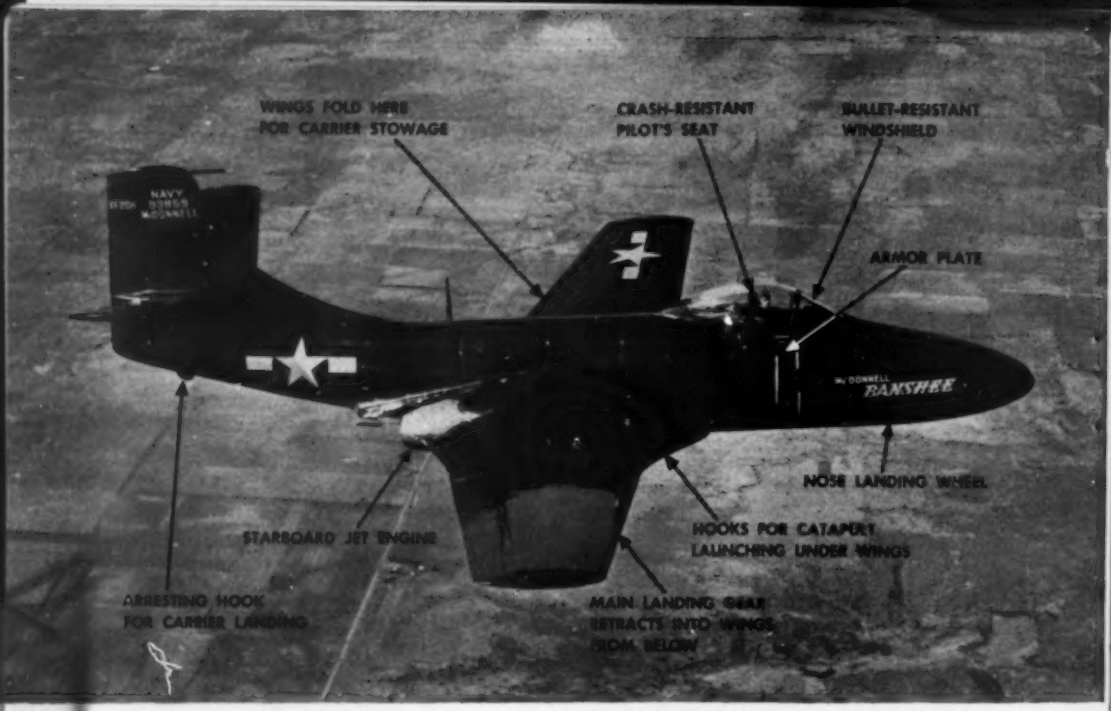
A HELICOPTER enthusiast recently wrote a book, which he entitled "Anything a Horse Can Do." That may be stretching it a bit, but the "windmill" planes have shown themselves workhorses of the air in many fields. Aside from their dramatic rescue work, helicopters have proved successful in delivering mail and packages, making aerial surveys, laying pipe lines, and have even made a bid in the weight-lifting field. A cheap personal helicopter or an ocean-crossing type, however, is still in the future.



The Bell "Airmailer" helicopter is equipped with twin external duraluminum saddlebags, each holding 10 mail sacks. Maximum mail load of this aerial pony express is 500 pounds.

Rubber pipe line was laid by helicopter during a recent test at Fort Belvoir. Unreeling 400 feet of tubing in 25 seconds, the experiment proved the air-laying of emergency fuel lines across inaccessible areas to be practical. The hose, folded in container under plane's body, is pulled out by anchor, laid in straight line. It can also be used to supply water.

This rubber tank, holding 3,000 gallons and weighing 150 pounds, can be folded up and released from a plane. It serves as a storage tank for fuel supplied by a helicopter-laid pipe line.

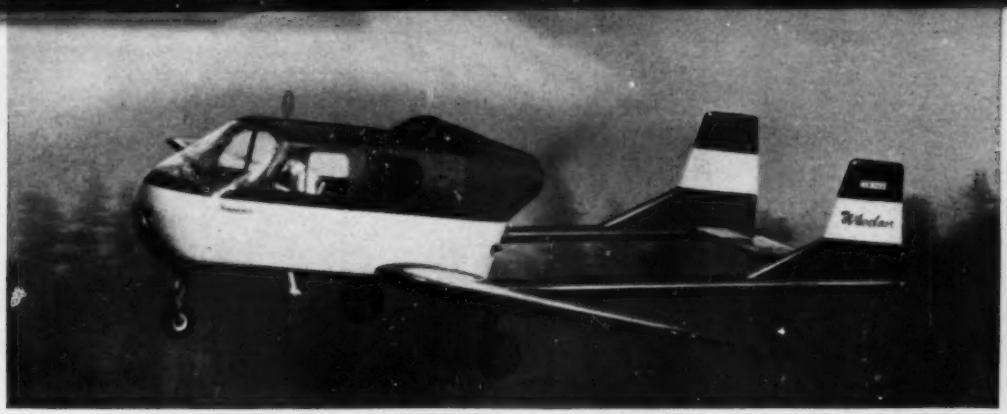


Fastest Fighter?

THE Navy claims that its new F2D Banshee twin-jet fighter is "the most powerful single-seat fighter flown in the United States today." It is predicted that the McDonnell-built Banshee will not only break the existing 616 and 619 m.p.h. records of the British Gloster Meteor and the AAF's Thunderjet, but that in a speed dash it may push the performance of a special supersonic test plane. Two Westinghouse Yankee 24-C axial-flow turbo-jet engines, most powerful American jets yet used, are counted on to overcome the heavy load of armor and armament, plus the added weight necessary for carrier operation. With wings folded for stowage, the plane's 41-foot span is reduced to 18 feet. All flight tests have been completed and production is under way.

Taken For A Ride

BLAZING nine-inch pulse jet suspended under the belly of this Navy JD-1 attack bomber adds no speed to the plane, but is being tested for airborne performance at high altitudes. Pulse-jet engine is what gave power to the Nazis' famous V-1s.



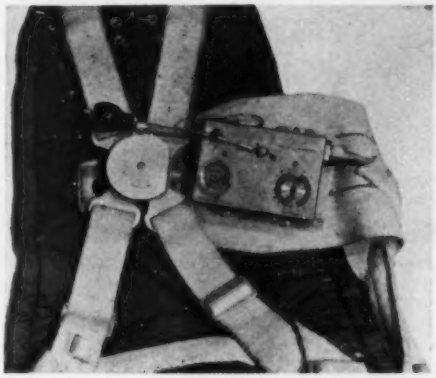
Winner Tries Wings

THE Wheelair 111A, which won the PSM Airplane Design Competition in 1944, has made its first test flight. The Wheelair, made by Puget Pacific Planes, Inc., is a twin-tail pusher, with a top speed of 140 m.p.h. and a range of 600 miles, carrying four passengers and 160 pounds of baggage. With simplified controls, it is spinproof, stall-resistant, and has nylon fuel tanks of the type used in large transport planes.

WHAT'S NEW in AVIATION

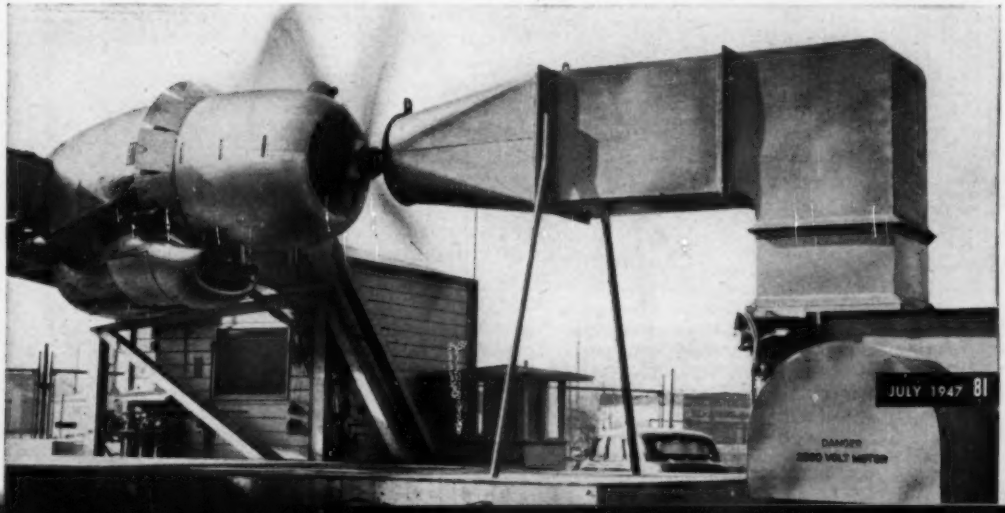
Parachutist's Friend

FOR high altitude bail-out, the Irvin Automatic Opener can be set to open a parachute automatically at a height where air is dense enough to breathe. Low-altitude jumper presets timer, which delays opening until he has decelerated to a speed at which he can withstand opening shock. Rip cord can be pulled manually any time.

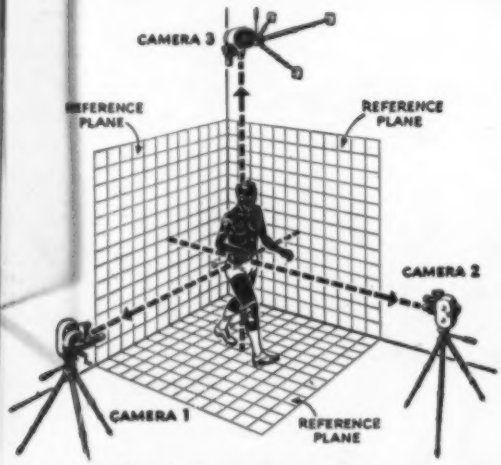


Wind-blown Wasp

AN ELECTRIC blower pours a steady cooling "wind" of 200 m.p.h. into a 3,500 horsepower Wasp Major engine, power plant of Boeing's 80-passenger Stratocruiser. Test will simulate 28,000 miles of flight, consume 47,000 gallons of gasoline.



Stainless steel pins with table-tennis-ball heads were fastened to bones of volunteers, and slow-motion pictures recorded inward and outward rotation of hip and knee bones during walking.



Synchronized cameras are shown in positions used during human "pincushion" walking tests.

New Twists Make 'Peg Leg' Really Walk

Through ingenious studies of how normal limbs function, engineers are helping amputees.

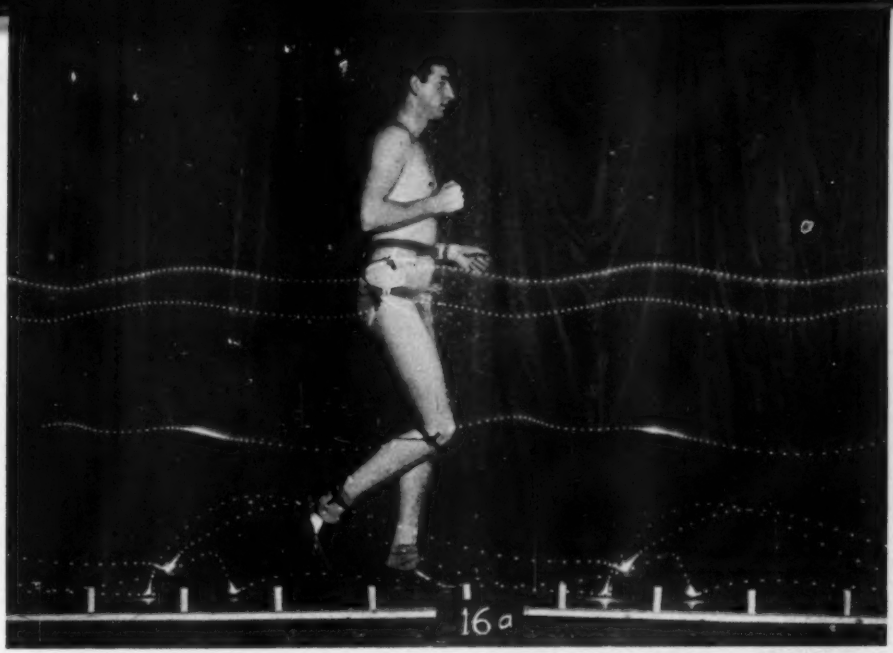
ONE spring day late in the war Howard D. Eberhart, civil engineering professor from the University of California, was testing the runways of the Army's Hamilton Field, using a big trailer to find out if the surface could support heavily loaded B-29s. Professor Eberhart fell. The 100-ton trailer rolled over him and crushed his left leg.

That accident, quite literally, has produced a "revolution" in the designing of artificial limbs. A leg that can twist, duplicating the complex "screwing" motion of normal walking, has been produced after two years of research directed by Professor Eberhart and Dr. Verne T. Inman, orthopedic surgeon, at the University of California.

Vacuum Principle Revived

This artificial limb not only enables a legless person to walk more like a person with two sound legs, but is also more comfortable. It is held in place by vacuum—a principle used in the Civil War but redeveloped independently by the California researchers. This eliminates the discomfort of awkward metal hinges and harnesses.

Additional ways of improving the "pegs" of 17,000 war casualties are being sought now, not only at California, but also at two other educational institutions and by a dozen industrial concerns, under a nationwide program of the National Research Council's Committee on Artificial Limbs. Legless veterans will not be the only bene-



"Interrupted light" studies provided information on speed of walking. Subject, with tiny lamps strapped to pelvis, hip, knee, ankle, heel and toe, walked across dark room while camera with revolving shutter photographed his stroll. White dots in picture shown above trace his path; dots close together indicate low speed; those farther apart, a higher speed.

How an amputee walks, favoring his artificial leg, is shown above by Professor Eberhart, using interrupted-light technique. The straight lines connecting dots give more complete picture of body action, including shoulder and head. A study and analysis of these changes in locomotion contributed to the development of an artificial leg with better walking characteristics.

New artificial leg is the first that permits rotation of foot as in natural walking. Steel torsion rod within shin piece permits the foot to toe out and in as much as two inches from straight ahead. Arrows in above pictures show variation in opening between bumper and stop from time heel touches ground and toe completes step. Guards prevent foot from turning too far.

Aluminum "pylon" that measures forces acting on an amputee's leg. When pylon is substituted in shank of artificial limb, electrical gauges measure the torque, axial and vertical loads.

"We must mimic the action of the normal leg," maintains Professor Eberhart. He is shown here checking an adjustable artificial limb that is used to determine the needs of individuals.

ficiaries—every year, 25,000 civilians lose an arm or a leg!

California's team of 50 researchers, drawn from the College of Engineering, Medical School and Anthropology Division, started at the very beginning: They set out to learn how people walk. They made 16 different studies of the way human and artificial legs work, in many cases using ingenious new research techniques.

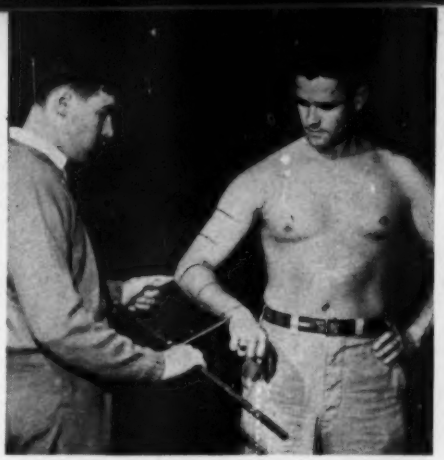
Which parts of the foot exert the greatest pressure? And when? The doctors found that out with the help of a trick stage. It had a multilayer floor: heavy plate glass supporting two layers of pliofilm and a rubber mat. Foot pressure squished down the mat, forcing projections in its bottom against the pliofilm, one layer of which was coated with a white paint. In this way, the projections corresponding to the areas of most pressure made contact with the glass plate, creating a pattern of black and white dots that could be photographed with a motion-picture camera and mirror. The dot patterns recorded on the film then told the researchers how each part of the foot exerted pressure during walking.

Muscular Electricity Tested

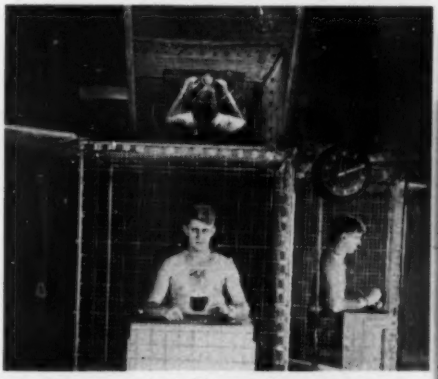
Since a good artificial leg would have to be controlled by the amputee's remaining muscles, the California group measured the energy changes in muscles during walking by recording the faint electric currents they produced. Volunteers paraded around the room with electrodes fastened to eight major leg-muscle groups. Long wires trailed behind them, leading to a modified electroencephalograph. This instrument, long used to study electric currents originating in the brain, can amplify these faint impulses 50,000,000 times. The output of the encephalograph was recorded photographically from cathode-ray tubes.

From these diversified attacks on the problem came the new and vastly improved artificial leg. The device finally developed uses a torque rod inside an aluminum tube to permit the toe of the foot to swing through a four-inch arc at each step. When the foot leaves the ground, the torque rod pulls it back to a straight-ahead position. A bumper and two stops prevent the rod from twisting too far in either direction.

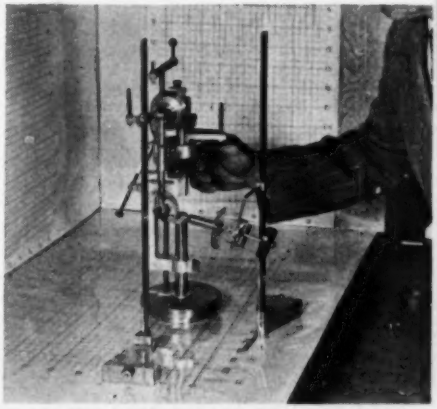
Yet the scientists are still not satisfied—and won't be until they can make an artificial leg that does about everything a real one can do. END



U. of C. researchers are also making studies to perfect artificial hands. Here one is shown taking exact measurements of forearm length.



Hand patterns in holding and grasping are determined by photographing subject from straight ahead, and through top and side mirrors.



Using kinematic analyzer, researcher transfers information obtained from pictures to grids. The result is a picture of typical hand patterns.

Russia's Growing Air Power

TB-7. Four liquid-cooled, 1,350-hp. engines give it a cruising speed of about 200 m.p.h. carrying bomb loads up to 11,000 lbs.

If willingness to expend money, men and materials can do it, U.S.S.R. will become the world's No. 1 air power.

By the Editors of Popular Science

THE Union of Socialist Soviet Republics proposes to become the world's greatest air power. Russian determination to be first, her increasing expenditures on research, her growing skills, her vast potential of men and materials make her today second only to the United States.

Right now, the Red Air Fleet consists of more than 30,000 planes, compared with the U. S. Army and Navy's 40,000. But half of ours are in storage, and despite careful "pickling" will have to be scratched in a few years. And Russia plans to produce 20,000 warplanes in 1947; the United States, not more than 3,000.

Russia's military aircraft are mostly fighter and light attack-bomber types. Hence, at present, the Red Air Fleet is probably better prepared than the AAF for *defensive* air war, and America is better prepared than Russia for *offensive* air war.

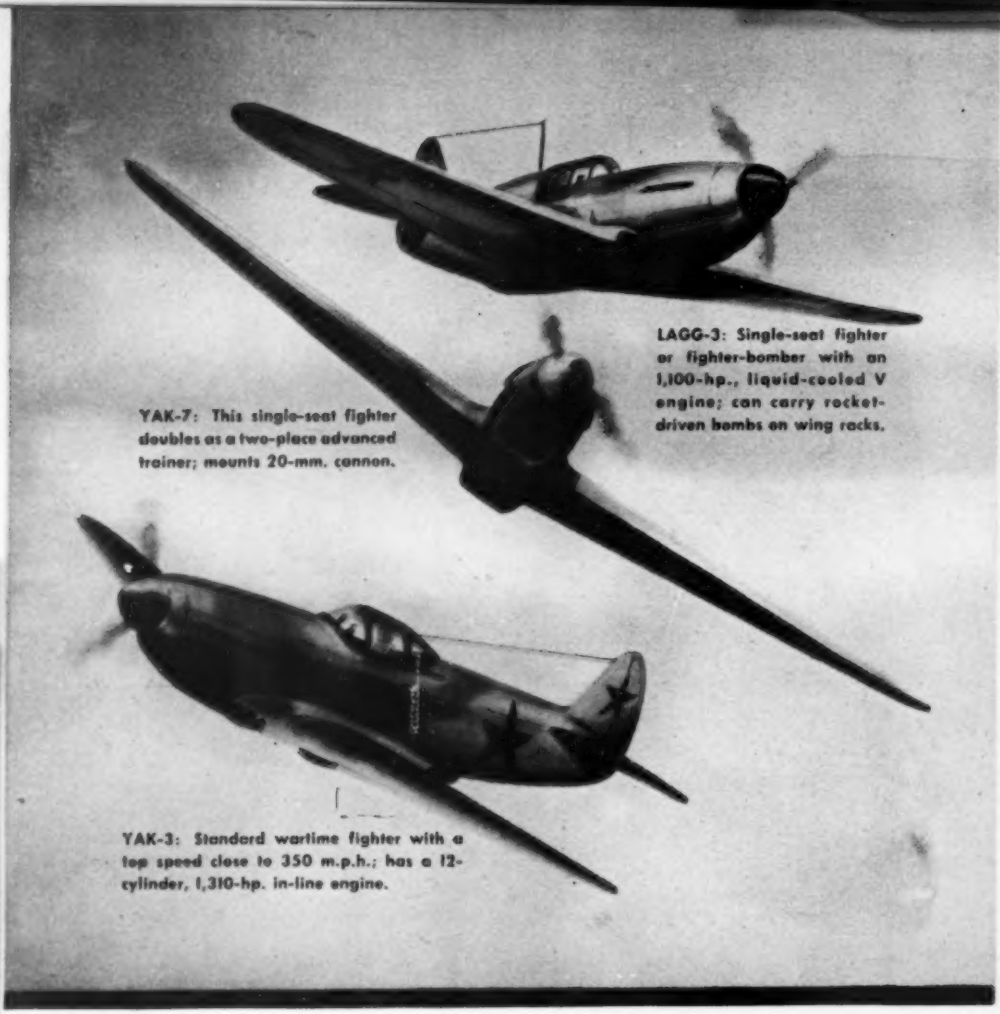
Russia's budget for research and development this year is five billion rubles; the comparable figure for the United States is $350,000,000. Comparing rubles and dollars, however, is extremely difficult. The official rate of exchange is five rubles to the dollar; the unofficial rate is 12 to the dol-

lar; the black market rate is 40 to the dollar. ***But, significantly, the Russians have increased expenditures for research while America has been curtailing such expenditures.***

These statements are based on the studies of experts in the Army Air Forces, Naval Aviation, the British Royal Air Force and the Russian Air Fleet's own leaders.

Contrary to much current opinion, Soviet aircraft design is distinctly Russian. Aviation holds a high and respected place in Russian history and science. Soviet authorities point out with considerable firmness that the first airplane was designed by A. I. Mozhaisk, a naval officer, in 1882; that Euler and Bernoulli laid down the principles of aerohydromechanics; that Lomonosov founded the science of meteorology; that modern aircraft design is based on Zhukovsky's laws of aerodynamics. The dozens of aeronautical institutes founded in the Soviets show how determined they are to excel. Visitors to the Central Institute of Aerohydrodynamics, the Zhukovsky Airforce Academy and the Moscow Aviation Institute say they have no equal here.

In World War II the Russians emphasized the use of fighters and light bombers to support the ground forces, but they now are placing extreme emphasis on production and tactical training in the heavy-bomber field. Red Air Fleet leaders saw what happened to Germany and Japan through strategic bombardment, and keen analyses have been published in Russian on



LAGG-3: Single-seat fighter or fighter-bomber with an 1,100-hp., liquid-cooled V engine; can carry rocket-driven bombs on wing racks.

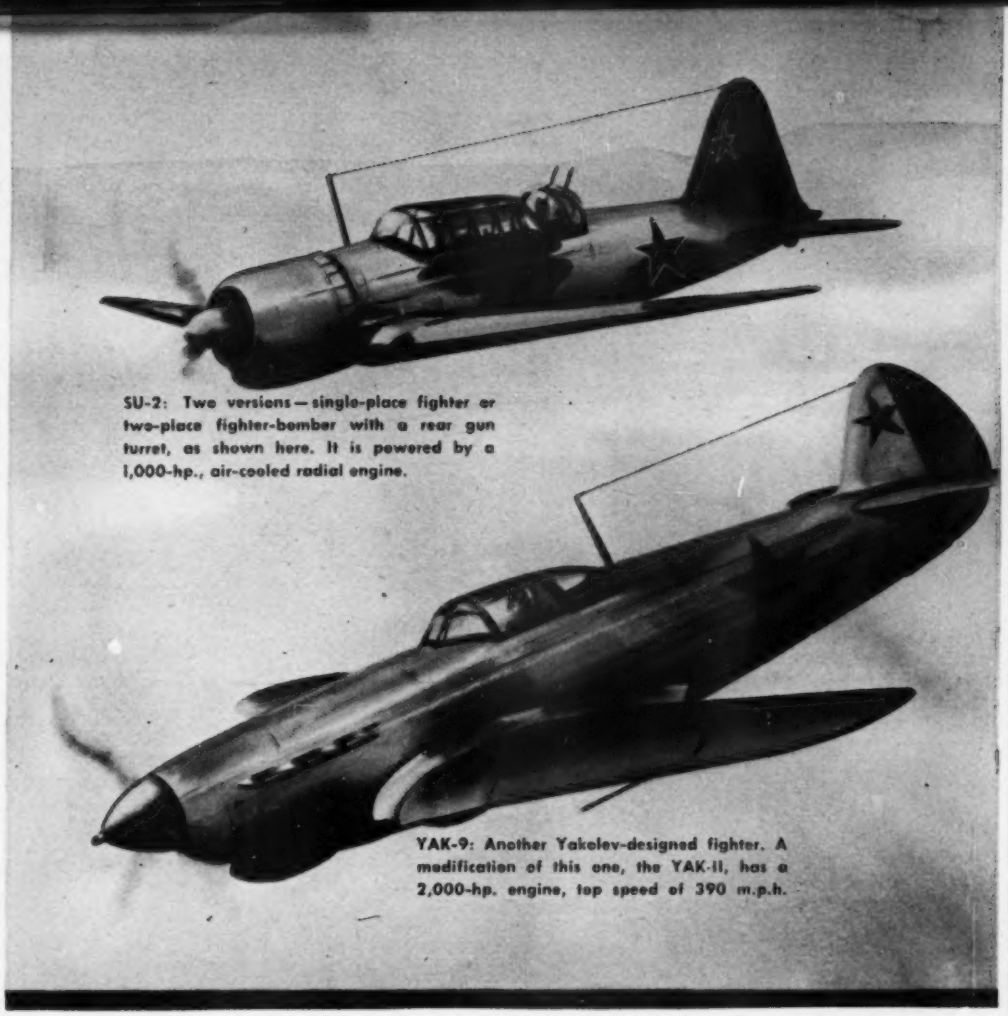
YAK-7: This single-seat fighter doubles as a two-place advanced trainer; mounts 20-mm. cannon.

YAK-3: Standard wartime fighter with a top speed close to 350 m.p.h.; has a 12-cylinder, 1,310-hp. in-line engine.

the techniques of this phase of aerial warfare. Red Air Fleet tactics on the whole are sound.

Their designers are good, too. Working under pressure as the Nazi hordes swept toward Moscow, Sergei Ilyushin had the first version of his Stormovik in the air before the fighting had gone 100 days. It strafed the advancing enemy from 100-foot altitudes while the German light ack-ack bounced off its reinforced hide. German fighter squadrons were loaded with deadly Messerschmitts. Someone had to design, but quick, a plane to cope with the hard-hitting, maneuverable German fighters. So Alexander Yakovlev got out his Yak-1 fighter, forerunner of the now-renowned Yak family of fighters and bombers. S. Lavochkin fighters, Petlyakov's efficient PE-2 dive bomber, A. Tupolev's TU-2 bomber—all were developed under stress of conflict.

Comparison of the best planes of the U.S.S.R. and the U. S. is difficult because the Red Air Fleet doesn't have to roll out its new stuff to obtain popular support for air-force appropriations. Russia is flying at least two types of jet fighters and two rocket planes about which little has been disclosed. Jet engines have been used in at least one Russian heavy bomber. One hundred jet planes flew in a demonstration over Red Square last spring. A Russian axial-flow jet engine has developed 6,000 lb. thrust, 50 percent greater than our standard jet. The work of German jet scientists who were "imported" wholesale after the war accounts for



SU-2: Two versions—single-place fighter or two-place fighter-bomber with a rear gun turret, as shown here. It is powered by a 1,000-hp., air-cooled radial engine.

YAK-9: Another Yakolev-designed fighter. A modification of this one, the YAK-11, has a 2,000-hp. engine, top speed of 390 m.p.h.

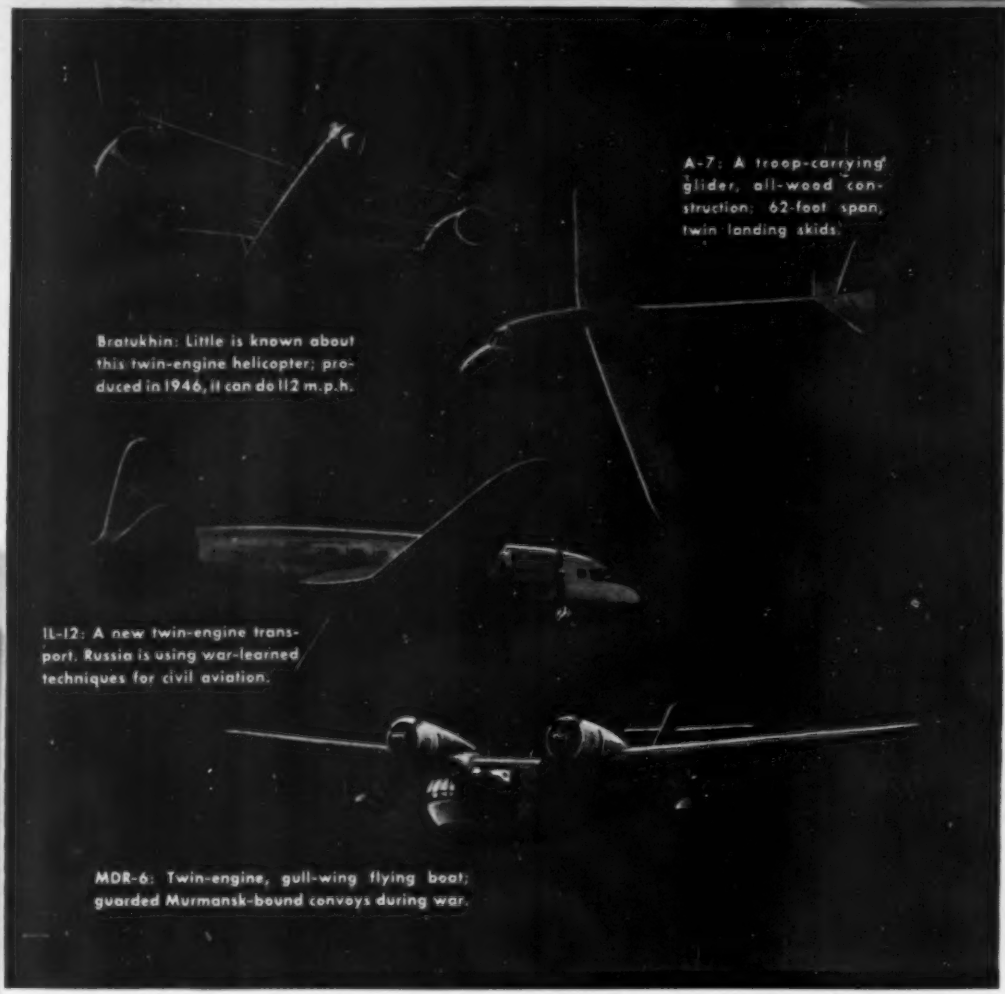
much of the air progress made by Russia.

More immediately important than new developments, is the question of comparative merit of present planes. The tricky problems of arming and maneuvering the lightning-fast jets make it highly probable that it will be quite a while before conventional designs are outmoded. The question, therefore, is how do Soviet warplanes stack up today?

In the fighter category, the Red Air Fleet's planes hold their own in speed, maneuverability, armor and armament. In attack bombing the Russian types must be given the nod because of the Red Air Fleet's extensive World War II experience in this activity. The United States holds an undisputed edge in heavy bombardment types. The latest two Russian four-engine bombers are good aircraft of sound design, but they have neither the range nor capacity of our own. One long-range heavy, with a 300-m.p.h. speed, is in production.

In transports, American equipment is unexcelled. But U.S.S.R. equipment is good; they have enough of it—and in military transport, volume, rather than speed, is of first importance. Supplies and troops fed in by air at 200 m.p.h. can support any operation properly, if the pipe line is kept full.

As to flying boats, there is a question. Russian types are quite old, but the Red Air Fleet has used them in numbers and to advantage, while in this country interest in this type has lagged. Flying boats, landing and taking off from lakes behind the Nazi



lines, supplied many Soviet guerrilla units.

Air power means man power, too. Russians make good pilots. They are famous for fearlessness.

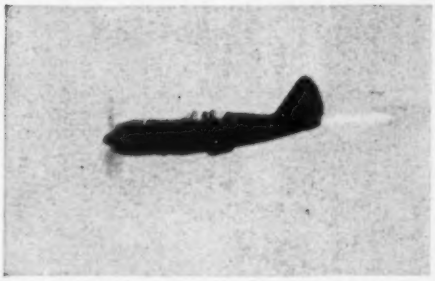
Behind planes and fliers must stand factories and workers. Russia's labor situation is hard to assess. In her regimented economy, labor is paid 1/5 to 1/7 what it gets in America. But the same ratio is said to exist in output—a U. S. mechanic earning $75 a week is reported seven times as skillful as his Russian opposite number. Offsetting this is the fact that the government can and does move factory populations like checkers. Right now, Russia is funneling children of 15 into her F.Z.O. (Industrial Training Schools) system.

At the same time Russia's traditional dependence on mass labor is decreasing. For the past 15 years, there has been ever greater use of automatic machinery, even though it had to be bought at unfavorable exchange rates. After World War II came wholesale transfers of the finest German machinery to Russia. Now, nearly 60 percent of all of Farbenindustrie, and almost 50 percent of all other German industrial equipment works for Russia.

When it comes to raw materials for her aircraft industry, Russia is rich in some, poor in others. She has plenty of aluminum and magnesium, both at home and in satellite Hungary and Yugoslavia. War-pressed developments have provided the power formerly lacking to extract and process these vital items. A plant at Kamensk in the southern

Urals and the still-growing BAZ factory in the northern Urals are adequate to make all the fabrications needed.

Of manganese and chrome, Russia has so much that in 1946 the United States imported 204,062,000 lb. of the former from her and 67,586,200 lb. of the latter. In the ferroalloys, however, the Soviets are poor: so poor that the third Five Year Plan, launched in 1938, was tagged "The Plan for Quality Steel." During the war years, more than 21,000,000 lb. of ferrotungsten, ferrochrome, ferrovanadium and ferromolybdenum, worth more than $12,000,000, were shipped to Russia on lend-lease.



This streaking shadow is the first photo of Russia's rocket-assisted airplane.

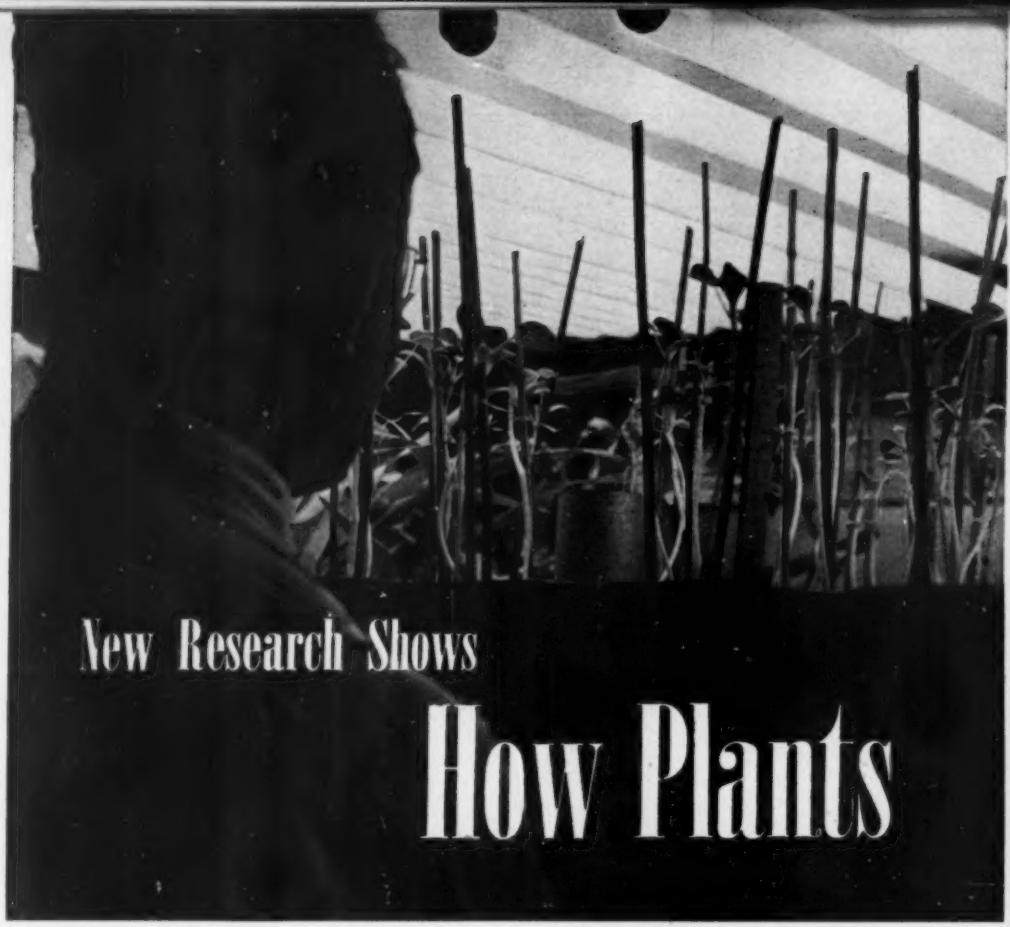
A not-so-obvious asset of Russian air strength is her bases. Thousands of airfields, from small grass strips to huge, modern, paved airports dot the country. Three distinct chains of bases mark a way for profitable international transport to the United States Pacific Northwest, Midwest and East Coast. That these might be transformed overnight into military installations is no more true than a similar statement regarding our Alaskan airfields. A sectional Siberian air map chosen at random, covering a 600- by 700-mile area, shows two dozen airfields at 100-mile intervals.

Equally important to Russian aviation is the weather forecasting system evolved by the Soviet. In a land of severe weather, successful year-round aviation depends on meteorological efficiency. In the last 10 years Russia has established more than 100 weather stations in the Arctic, extensively staffed with expert personnel and modern equipment. Here again, the U.S.S.R. doesn't quite come up to the U. S. in equipment and savvy, in the opinion of American experts, but Russia is expending more money and men and effort on such work than America. American military meteorologists admit the Russians' long-range forecasting is good, criticize their failure to make simultaneous observations, say their communications are not outstanding.

A powerful adjunct of Russian military aviation is the Civil Air Fleet, which has a far more intimate relationship with the military than does civil aviation in this country. The Kremlin is pushing a vast program of air-line modernization and expansion. From a few hundred miles of lines before the war, compared to our 28,000-mile network, the Russian air lines now cover 50,000 miles and project 108,000 miles by 1950. American air lines, meanwhile, have grown to 95,000 miles today. Construction of 20 principal new U.S.S.R. airports is planned. A new 60-passenger, 300-m.p.h. transport is being built, along with a 40-passenger seaplane for the Far East. LI-2s, built from the Douglas DC-3 design, are being turned out at 400 a month. Russia's civil aviation is further reinforced by Polish and Balkan air lines.

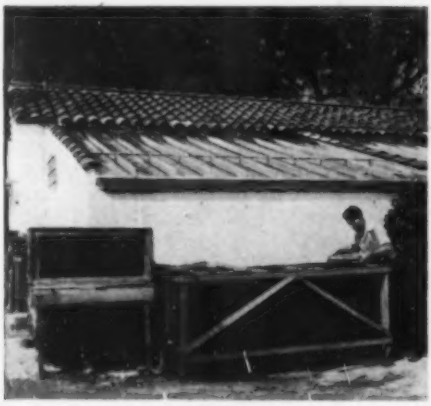
Sovfoto describes this as "A Soviet-built jet-propelled plane." Fill in your own details.

Qualitatively, American air power still holds an edge over the Red Air Fleet. Quantitatively the position is being reversed. Russian military aviation still faces plenty of high hurdles. It has a production problem; it is short on some phases of tactical knowledge; its equipment and over-all know-how probably do not quite come up to ours. But aviation authorities say the Russians are "intent, capable, and undismayed by obstacles." While our present skills are sharper, the Russians are pouring in men, money and materials. If they continue, they will become the world's No. 1 air power. END

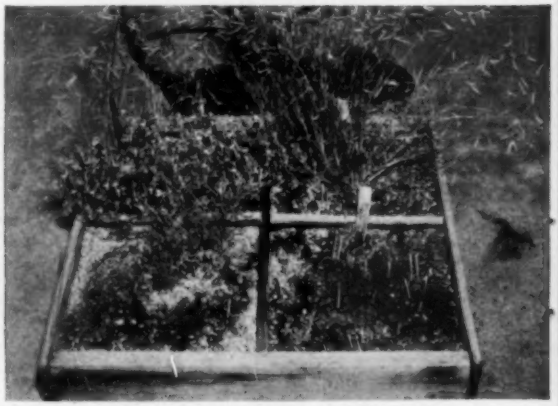


New Research Shows How Plants

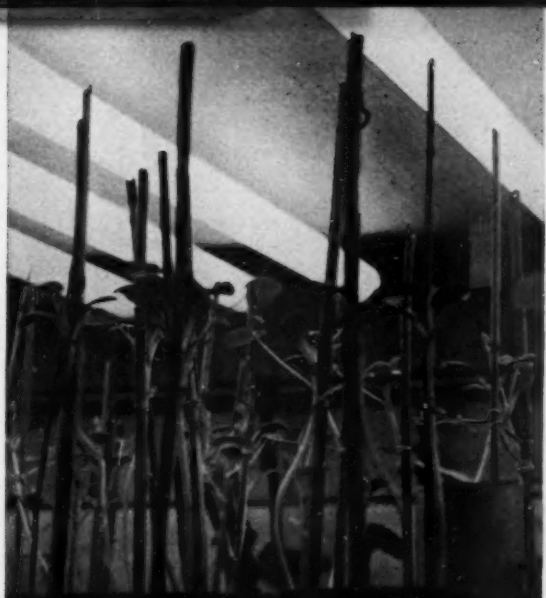
Relationship of light to growth is studied, using fluorescent tubes to simulate sunshine.



Caltech's scientific greenhouse is air conditioned so that temperature and humidity can be maintained at any level desired. Water sprayed over the glass roof neutralizes sun's heat.



Effects of rainfall are demonstrated by these four plots of soil from the desert. Rear two, soaked with rain, produced heavy growth. Front two were lightly sprinkled, grew little.



Grow

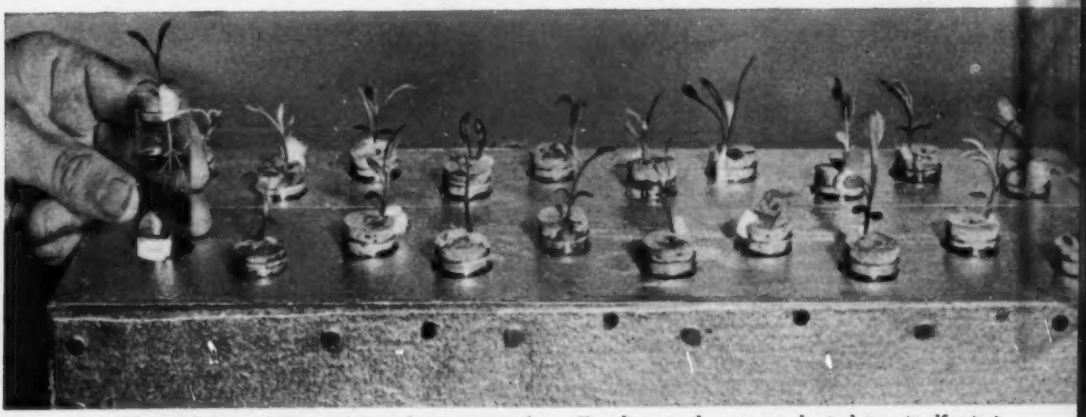
The subjects of this test are squash plants.

Caltech is exploding myths of garden and farm by investigating effects of sunlight, warmth and moisture.

HOW do plants grow? They do not have circulatory or digestive systems that can be studied like those of animals. But, by subjecting them to diverse conditions in a weather factory at California Institute of Technology, plant physiologists are finding out—and exploding many of the green-thumbed gardeners' pet ideas.

Plants do not sleep; they are as active in darkness as in daylight. Farmers often say hot nights are good for corn. The Caltech experimenters have found that night temperatures are important—but that corn really grows fastest when the nights are mild, 60 to 65 degrees.

Some plants help others. The desert sagebrush, for example, lets blossoms of the little Rafinesquia penetrate between its stems and leaves to find the sun. But other plants wage chemical warfare on their neighbors. The desert plant guayule, which produces a kind of rubber, grows twice as lushly on the sides, and four times as lushly at the corners of a field, as in the center because it excretes a poisonous acid around its roots that prevents the germination of other guayule seeds and limits growth of near-by seedlings. This acid, called an inhibitor, is so powerful that it can kill seedling roots in a day.



Many plants release poisons that prevent the germination of near-by seedlings. These shoots of guayule, a source of rubber, exude cinnamic acid, preventing the growth of neighbor plants. Encelia, a desert weed, isolates itself similarly. Through such natural chemical warfare, some plants are able to protect themselves against the growth of competitive species.

Night growth of tomato plant being measured. Although the plants usually die after two days in the dark, they will live for a week if the leaves are dipped in a sucrose solution.

The sugar solution that keeps plants alive in the dark can be applied more easily by spraying it on the leaves. A detergent is added to make the liquid spread over the surface.

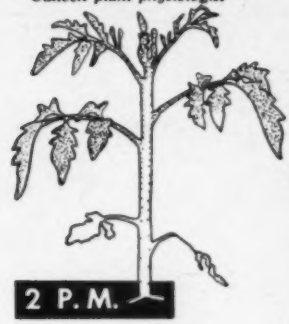
Injection of sugar directly into hollow stems of an acorn squash reveals how food travels to growing top of plants. This treatment made the squash gain two inches a night for three weeks.

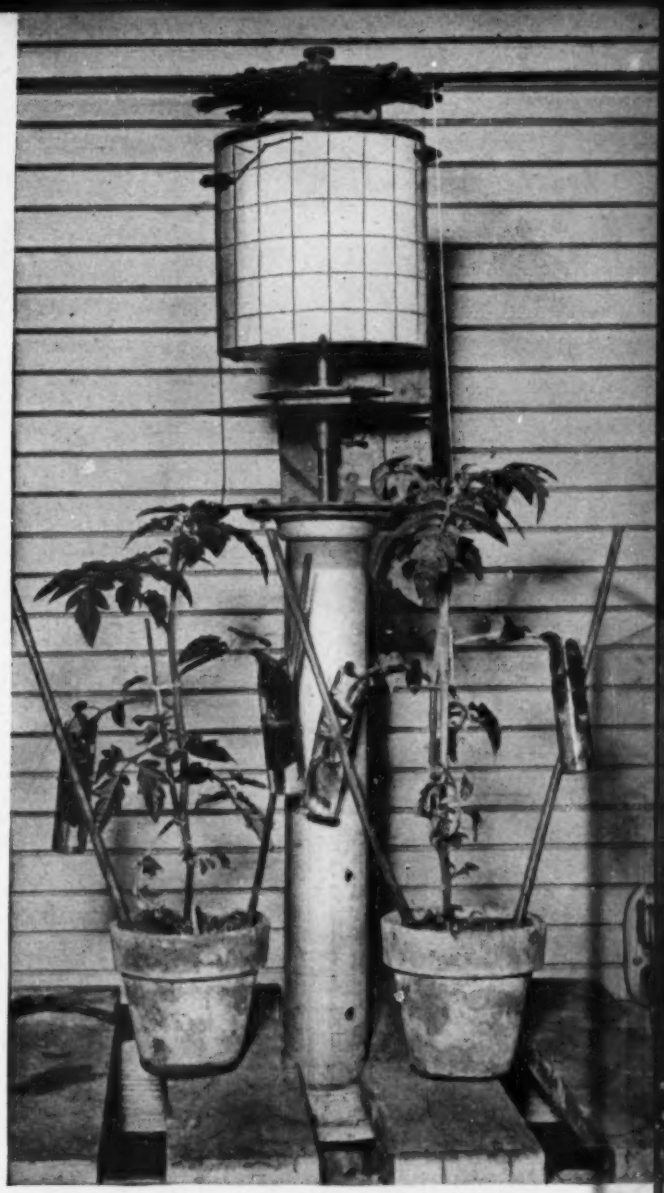
Experimental tomato plants thrive in wire baskets filled with expanded mica. Mica holds the upper roots where they can get plenty of air; the lower roots soak in plant-food solution.

Tomato-feeding tests show that sugar enters the plant through its leaves.

TOMATOES, squash, and corn are Caltech Professor Frits W. Went's vegetable guinea pigs. The tomatoes, his experiments have shown, take sugar through the leaves, not appreciably through the roots. Once, nitrogen and water were believed to influence transition from flower to fruit. This is not so. Conditions between sundown and sunup determine whether plants will fruit or flower, and how fast they grow.

Drawings by Mrs. Marcella Carter, Caltech plant physiologist

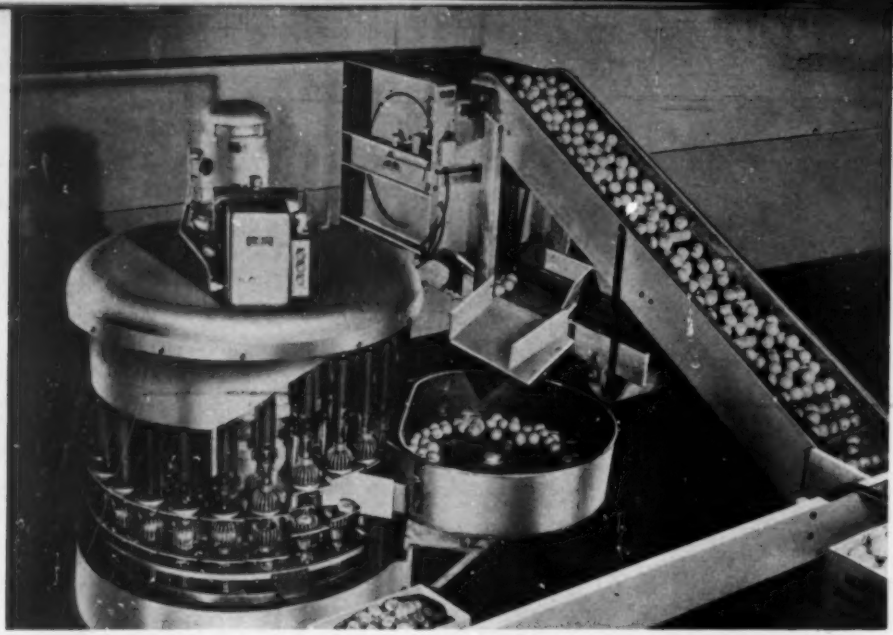




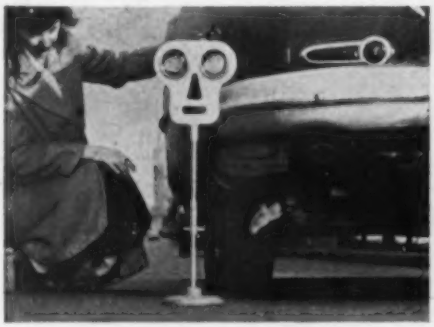
Movement of sugar in a tomato plant is shown in these sketches. When the plant stops making sugar (black dots) at 2 p.m., leaves are full while stem has very little. By 3 a.m., most of sugar has moved to stem and plant is growing fast. At 6 a.m., almost all sugar is gone; the plant stops growing and starts making more. Instrument above traces growth on drum.

Tomato plants quit work at 2 p.m., but they grow on sugar during night.

TO LEARN more about photosynthesis, the mysterious process by which plants manufacture the sugar they need to grow, Dr. Went's group tested the effects of varying amounts of sunshine on tomatoes. They found that these plants actually knock off around two in the afternoon, making no more sugar no matter how bright the sun. Not until around midnight did the tomatoes start turning this sugar into growth. END



Super Squeezer. Pressing up to 480 oranges a minute between metal cups, this new automatic juicer makes 300 gallons of juice an hour. Squeezing fruit whole, it eliminates rind oil, thus improving flavor and the keeping quality.



Portable Road Signal. When trouble makes a stop along the highway necessary at night, this easily folded Sav-A-Life signal comes in handy. Its reflected light is visible 350 yards in either direction.

Coin Centrifuge. This cement mixer breaks coin rolls, dumps loose change in bags for Federal Reserve deposit five times faster than by hand. A blower disposes of paper. It was idea of a Los Angeles teller.

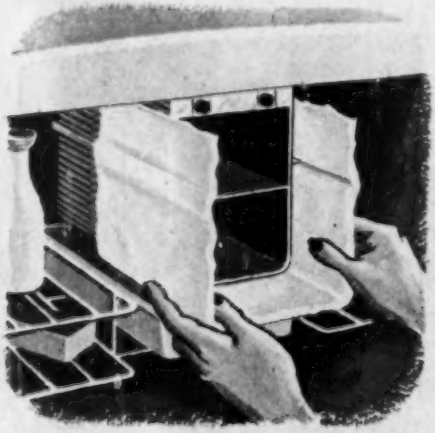
This Month's Pin-up

WITH a top speed of 170 m.p.h., the Navy's Fairchild XNQ-1 primary trainer has the latest safety devices, such as a bubble canopy for unobstructed view. It is an all-metal, two-place, low-wing monoplane with a 320-hp. Lycoming engine, controllable-pitch propeller, and retractable landing gear. The plane won a design competition.

NEW IDEAS from the INVENTORS

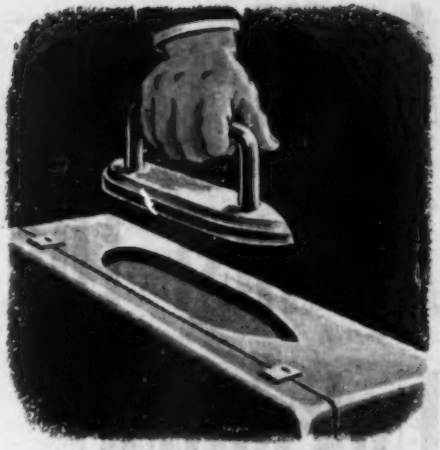
Auto Hood Has Nothing to Hide. An accessible motor for your automobile is the object of an invention of Renwick J. Sharp, of Guatemala. Hard-to-reach engine parts, usually hidden by the conventional hood, are instantly exposed when this one-piece half-hood and fender combination, hinged at the front of the radiator, is swung out horizontally, like a door. A similar system is also proposed for the rear of the car.

Pot Grinds Own Coffee. To prevent the loss of flavor that occurs after coffee is ground, Boris Bogoslowsky, of Jackson Heights, N. Y., has devised a pot in which the coffee is ground directly into a sack submerged in hot water, thereby keeping the flavor from escaping into the air. As the grinder is rotated, water is drawn through small holes in the shaft and circulated throughout the filter sack.

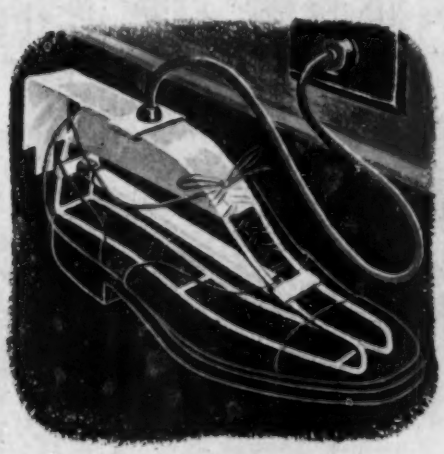


Heat Speeds Defrosting. You can defrost your refrigerator in minutes instead of hours with an invention of Charles J. Roach, of Hamilton, Ohio. Small heating coils, built into the sides of the freezing unit, are turned on just long enough to loosen the ice, letting it slide out in one piece. The built-in coils would melt the ice so quickly, the inventor believes, that you wouldn't have to shut off the refrigerator.

Decoy Imitates Ducks. A mechanical duck decoy designed to do practically everything but get up and fly away has been patented by Carroll J. Rulison, of Baldwinsville, N. Y. Connected to an anchor rope, its wings are so hinged that the wave motion of the water, pulling on the rope, causes them to flap. When water is not rough enough, the same effect can be produced by tugging on a rope from shore.



Bag Holds Iron As Handle. For the convenience of those who never stay in one spot long enough to have their clothes pressed, Andrew W. Janosz, of Manchester, N. H., has invented a suitcase whose handle is actually that of a small flatiron. When the suitcase is to be carried, the base of the iron is fitted and locked into a similarly shaped recess in its side, leaving only the iron's handle exposed.



Lamp Chases Shoe Germs. You don't have to stuff your shoes with chemicals in a new shoe sterilizer invented by Marion F. Fortney, of Charleston, W. Va. Instead, a small bracket that can be fitted right inside the shoe is used to hold an ultraviolet lamp. The top of the bracket completely fills the shoe opening, so that no harmful rays can escape. It can be fitted into a wall bracket, if desired.

Tire Sections Save Flats. To prevent accidents caused by sudden tire punctures or blowouts, Morris and Leo Frankel, of Los Angeles, Calif., have patented a tire that is divided into eight separate segments, each of which must be individually punctured to cause complete deflation. When one segment is punctured, the adjoining ones expand to fill in the space, permitting the tire to continue in normal operation.

Artillery Against the Unknown

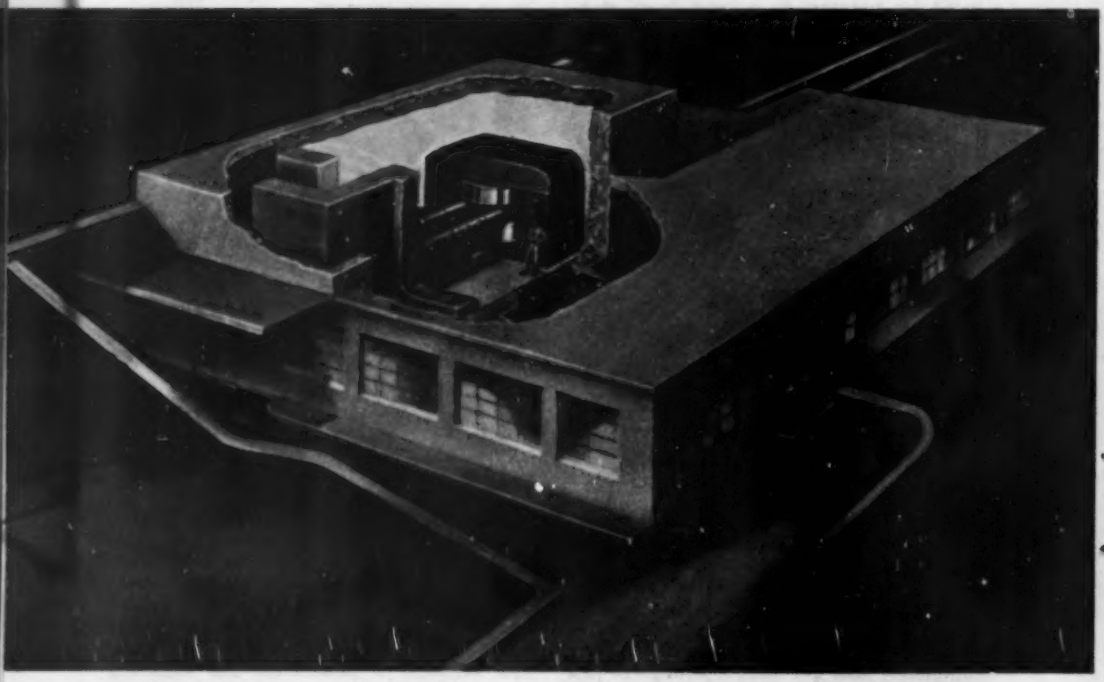
Brookhaven Laboratory is GHQ for reversing what happens when an atomic bomb explodes.

By Volta Torrey

CAN electrical energy be turned into real matter that will continue to exist? What are the forces, stronger than electrical and gravitational forces, that hold the nuclei of atoms together?

Related to these questions are many more: Can electricity be drawn *directly* from atomic piles, or can piles be used only as heat sources? How can engineers make certain that "nuclear boilers" will not explode? How are workers to be protected from "plutonism," which grays hair, damages the liver and causes bone cancer? Can an atomic power plant be made to fit into a locomotive?

The answers, needed to make atomic energy as useful in peace as in war, are now being sought for the Atomic Energy Commission in great new research centers such as Argonne Laboratory near Chicago and Brookhaven Laboratory on Long Island.



A 30,000,000-electron-volt cyclotron, expected to look like this, will be built at Brookhaven to create radioactive isotopes that cannot be obtained from atomic piles. Far larger machines are planned.

They are using two basic types of artillery against the mysteries of matter and energy: atomic piles for the production of power and radioactive isotopes, and huge machines such as cyclotrons and synchrotrons for the creation of other isotopes and further examination of atomic particles and forces.

Brookhaven scientists, for example, already have assembled material to build a uranium-graphite pile purely for research work. Power will be more concentrated in it than in the one at Oak Ridge, Tenn. It will be used to study metallurgical, construction and radiation-protection problems that confront the designers of atomic power plants. After this one, Dr. Philip M. Morse, director of the laboratory, hopes to go on to build larger and better piles.

Alongside these piles, a "hot" laboratory will be built to separate and package the radioactive isotopes which biologists and chemists use as "tracers." Radioactive isotopes that have more than the usual number of neutrons can be produced in piles, but the biologists often prefer to use tracers that have an excessive number of protons. Many of these are turned out in cyclotrons, so Brookhaven will also have a 60-inch unit.

Much more powerful machines than this are being designed—including a synchrocyclotron to produce a billion volts or more. At energies of about 200,000,000 volts, the theoretical physicists are reasonably confident, mesons will be produced.

But Dr. I. I. Rabi, Columbia University professor, Nobel prize winner and a trustee of Brookhaven, already has his eye on another more startling goal. That is to get into the region of energies of three or possibly four billion volts. In that region, he explains, "protons or neutrons are energetically possible."

Protons are the nuclei of hydrogen atoms. They would quickly pick up free electrons and thus become hydrogen. Hence, with energies of many billion volts, the scientists might reverse what happens when an atomic bomb explodes. Instead of matter turning into energy, energy would turn into matter.

What would a machine to do this cost?

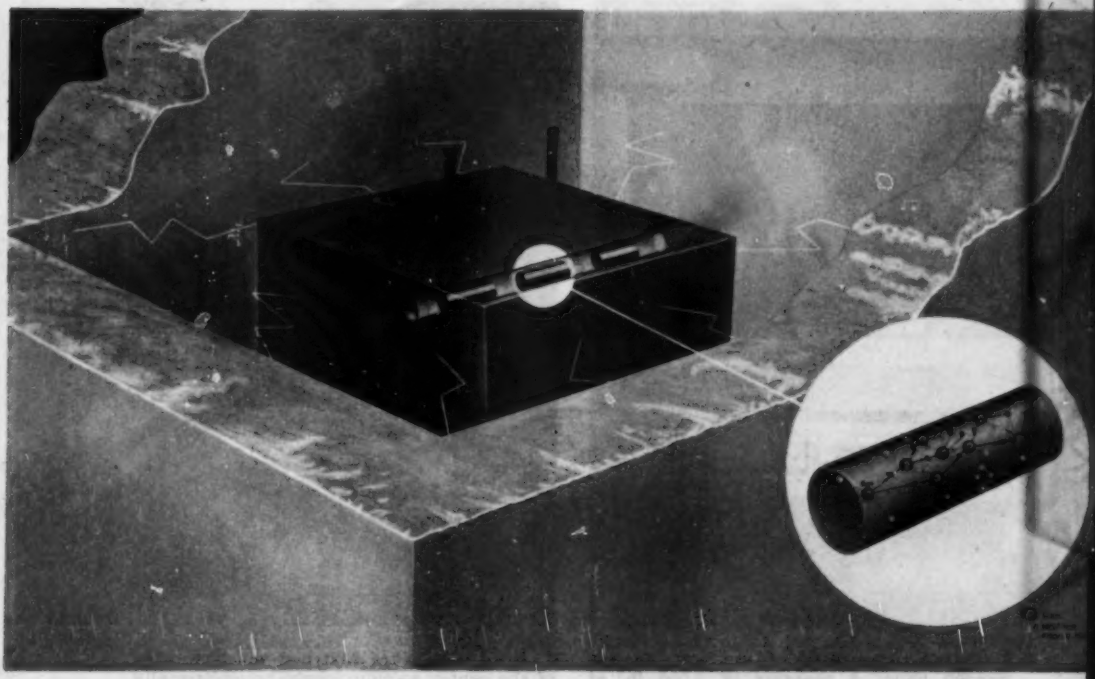
"Less than a cent a volt," says Dr. Rabi.

How soon could it be built if the money were available now?

"Three years," says Dr. Rabi.

"Five years," says Dr. Morse.

At Brookhaven, $10,000,000 will be spent this year, but $50,000,000 will be needed to complete the scientists' program. END



This visualization of an atomic pile was made with the help of Brookhaven Laboratory scientists. They expect soon to have a pile that develops more power per cubic inch than the one at Oak Ridge.

MECHANICS OF LIVING

Here's How Harmonicas Are Made

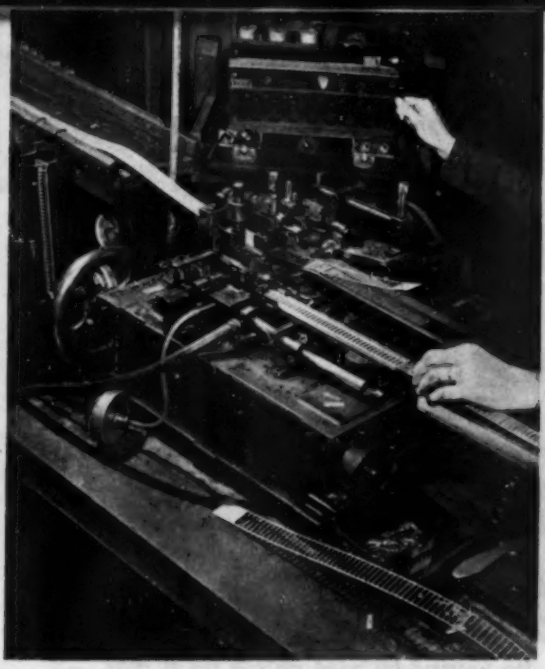
HARMONICAS, like many another product, have taken their place on U. S. assembly lines. Largely imported before the war, the ubiquitous and versatile instruments, more familiarly known as mouth organs, will be mostly American-made from now on.

With an estimated 3,600,000 slated for production in 1947 by one factory alone, the hip-pocket band has rapidly become a precision-made, mass-production commodity with a wide public appeal and an industry all its own. Invented more than a century ago, the harmonica was once a toy, is today a real instrument with complex 50-note chromatic models now available.

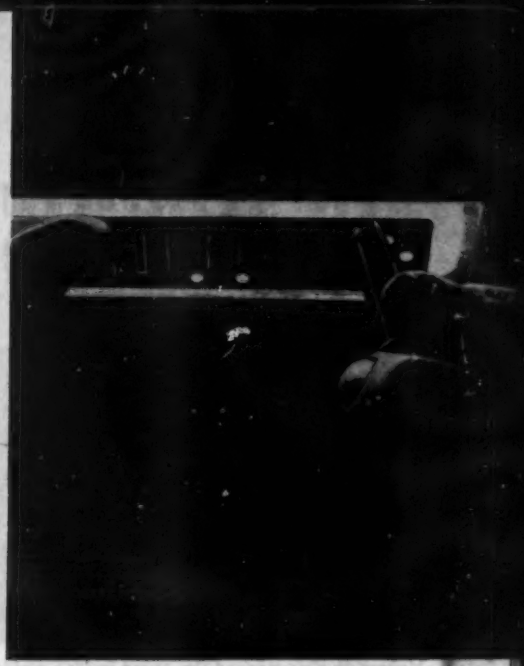
1. Brass strips, from which the reeds and plates are made, are first machine-tested for hardness and flexibility, which affect both pitch and tone quality of the notes.

4. Plastic cover plates, of polystyrene, are molded under a pressure of 1,500 lb. at 400° to 500°F. Some harmonicas are made entirely of plastic, even to their reeds.

5. Reed plates are fastened to either side of the center section, comblike and usually formed of plastic. Metal or plastic covers are then attached to complete assembly.



2. Milling machine turns reeds out of brass strips, giving each the exact shape and thickness required for its particular note. The reeds are then riveted to the plates.



3. A beam of light, shining through the reeds, is used to check their alignment after riveting. Tolerances must be held to a fraction the thickness of human hair.

6. Finished harmonicas move rapidly along a conveyor belt, assembly-line style, where they are individually boxed for shipment after first receiving a careful inspection.

7. Once a plaything, the harmonica is now making appearances at Carnegie Hall. Experts like John Sebastian (above) can play boogie-woogie or symphony with equal ease.

Air Medals

THE medals that commemorate the heroic achievements of aviation's pioneers are, in themselves, a history of mankind's triumphs in the air. Here are seven such flight medals that have been donated to the collection of the Institute of the Aeronautical Sciences. They were conferred by Congress upon the airmen who made or led historic flights.

Howard Hughes received this award in 1941. Holder of many speed records, he and four companions flew around the world in 1938 in 3 days, 19 hours.

This Congressional medal was only one of many decorations won by Charles A. Lindbergh for his nonstop New York-Paris flight on May 20, 1927.

Lincoln Ellsworth was honored for his 1935 Antarctic flight, when he claimed land for U. S.

Orville and Wilbur Wright flew in 1903, but Congress did not recognize the feat until 1909.

Members of the first Byrd Antarctic Expedition in 1928 won this award for their exploits.

Roald Amundsen was cited for his part in the first successful transpolar flight, made with Ellsworth and General Nobile in the Italian dirigible *Norge*.

U. S. Navy seaplane NC-4 was the first craft to fly the Atlantic, in 1919. Comdr. (now Admiral) John Towers and other crew members got this medal.

Second Jet Bomber

THE Consolidated Vultee XB-46, called the fastest of its type ever made in the U. S., is the second four-jet medium bomber built for the AAF. It resembles the North American XB-45, but is bigger: 105 feet nine inches long; wing span, 113 feet.

Solo Trainers Aid Flying Wing Pilots

THREE twin-engine Northrop N9Ms are being used by the AAF to train pilots for the big four-engine XB-35 and its eight-jet-engine counterpart, the YB-49. The single-place N9M, which has a 60-foot span, is powered by two 290-horsepower CGS-4 Menasco engines. In the photo at right the aircraft is shown in flight; below, a pilot gets some take-off tips.

Detailed cutaway view at right shows the working parts of the pump's steel-encased, oil-sealed electric motor. The submersible pumps may carry as many as 36 turbine blades, turn at rates up to 3,600 r.p.m. and raise fluids from depths as great as 1,500 feet. The man standing beside one of the larger models, at left, shows its height and massiveness.

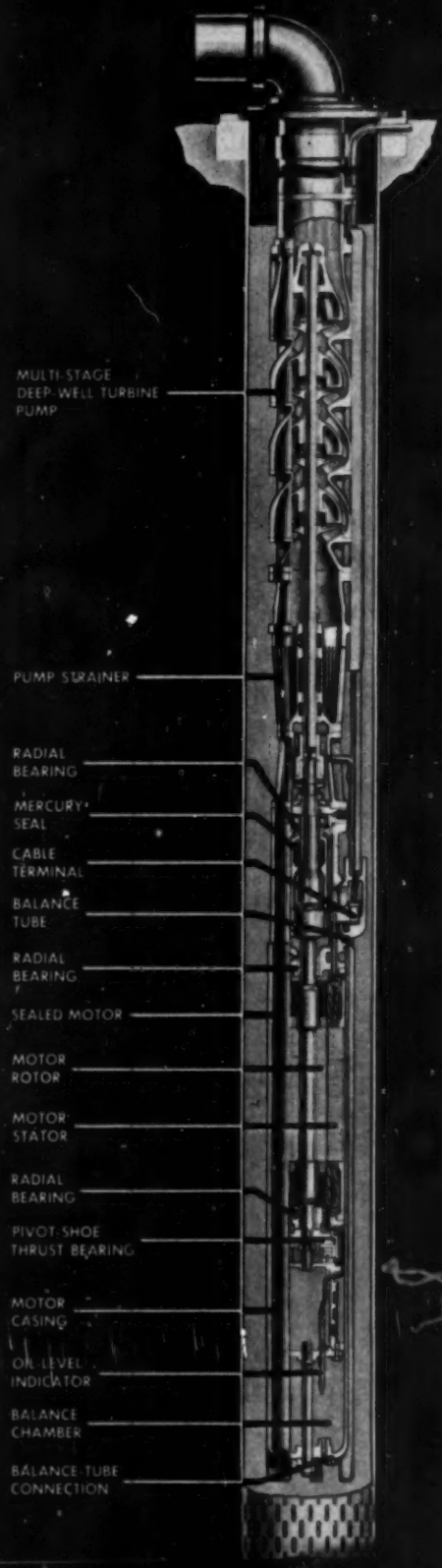
Versatile Pump Works Under Water

THIS whirling dervish is a giant industrial pump that carries its own power supply and is constructed to function efficiently even when completely submerged. Designed to pump both liquids and gases, its built-in, oil-sealed electric motor makes a long drive shaft unnecessary.

Developed by J. B. Van Horn, engineer for the Byron Jackson Co., of Los Angeles, the submersible pump has found wide use in such varied operations as fighting fires at sea, emptying damaged compartments in ships, draining flooded mine shafts, emptying drydocks, supplying water to cities and delivering volatile hydrocarbon products through refinery pipes.

Smallest models deliver only 7½ hp. and handle 25 gallons a minute, while the largest develop up to 350 hp. and can pump as many as 20,000 gallons a minute. Since the pump wastes no energy turning a shaft, it can operate at twice the depth at which ordinary pumps can work. In Arizona, the Miami Copper Company gets its water supply from a 1,200-foot shaft with a single pump 30 feet long.

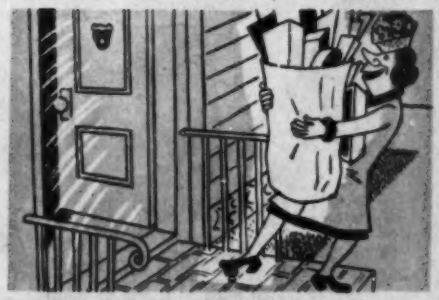
To make the pump submersible, its motor is enclosed in a steel case filled with a highly refined, water-impervious oil. A mercury seal prevents leakage at the top.



Everybody has his own pet idea of some gadget he would like to see in general use. What is YOURS? *Popular Science Monthly* will pay five dollars for every such suggestion that its editors decide to publish. Suggestions cannot be acknowledged or returned.

I'd like to see them make

Cartoons by SYD LANDI



Push-pedal Doors. Ones that would open at the touch of the toe would be a good idea, thinks Roy Myer, of Saugerties, N. Y. But what about unlocking them?

Roadside Sockets. For hungry motorists on long trips, Idamae Burati, of Newark, Del., would like to see coin-operated electric outlets installed on main roads.

Keep-heat Eat-aids. Hard-at-work husbands could enjoy hot home cooking if lunchboxes were like vacuum bottles, says Maurine Clements, of Lee's Summit, Mo.

No-lick Stamps. To spare tongue and taste a lot of torment, William Bunch, of Lakeville, Ind., suggests self-sticking postage stamps made in rolls like Scotch tape.

Two-in-one Eat-seat. A folding chair whose back raises to form a table would keep ants from the picnic food, declares Russell McGehee, of Nashville, Tenn.

Convertible Shoes. Interchangeable heels of different heights for women could make one pair of shoes suit various occasions, writes Ethel Geller, of Brooklyn.

Mapping the Milky Way

Dr. Jason J. Nassau, right, director of the Warner and Swasey Observatory, Case School of Applied Science, Cleveland, with a Schmidt telescope. It can record stars of less than 13th magnitude.

THESE shining little rainbows are clues. Each is the spectrum of a star—its signature in light. From them, astronomers hope to wrest the secrets of the Milky Way.

For the Milky Way is no haphazard streak of stars, but the island universe—supergalaxy—of which our sun is a minor member. It is roughly disk-shaped; we see it as a band across the sky because we are looking through the disk edgeways from a spot out near the edge.

Is it an old universe, or a young one? The answer may lie in the 100 million others scattered in our range. These run from globular clouds through flattened ellipses and vague spiral shapes to fully developed spirals with long, bent arms whirling through space. These are believed progressive stages of maturity; if we knew our supergalaxy's shape we could tell its stage.

We can't stand off to look at our Milky Way, so we must find its shape the hard way: by charting the distribution of its 200 billion stars by distance, size, temperature and color. This is no one-man job. All around our solar system, space is divided into cubic light-years—tremendous measuring blocks 3,900 billion miles on a side. Each star must be placed within its block.

If the structure turns out more or less uniform, the Milky Way is probably just a young, disorganized cloud of stars. But if the final map shows long streams of stars with relatively empty lanes between, then we can assume that the Milky Way is a spiral supergalaxy—and getting old.

Almost our only clue is light. Just by looking at a star we can tell its apparent color and its brightness, or magnitude. Breaking its light into a spectrum tells both temperature and true, or absolute, brightness (which distance and intervening obstacles make different from apparent brightness). Each element blazing in a star emits special wave lengths of light that make bright lines on its spectrum. Since elements incandesce differently at different temperatures, the presence of particular lines tells how hot a star is.

These same lines vary in strength according to the absolute brightness of a star. This was discovered by checking near-by stars whose distance could be figured geometrically. Distance plus apparent brightness allowed the absolute brightness to be found and matched to bright-line strength.

With temperature and absolute brightness

This color photograph of star spectra was made with the Schmidt telescope at the Case School. As many as 3,000 spectra can be recorded on one plate with a 20-minute exposure, thanks to the light-gathering properties of the telescope. Color photography does not yet give as much information as black and white spectra, but is useful for quick checking of star temperatures.

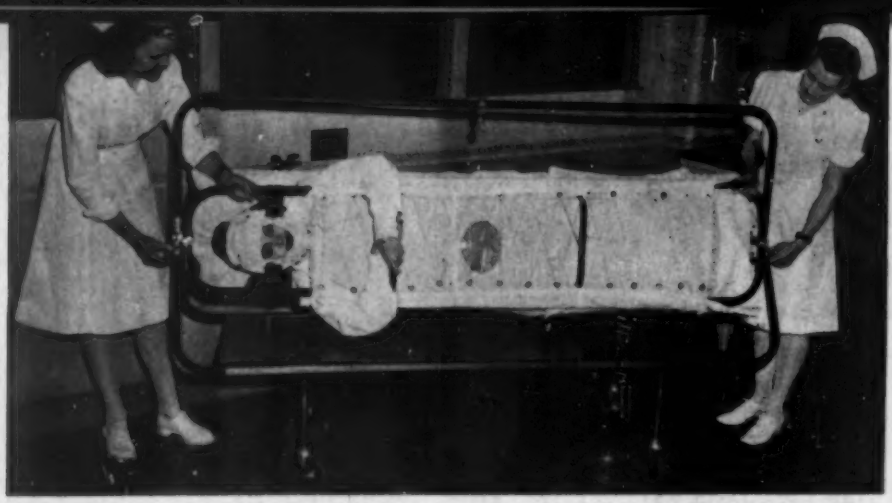
from the spectrum, and apparent brightness and color from observation, we can deduce the rest. Distance dims a star, so the difference between absolute and apparent brightness tells how far away it is. And since absolute brightness depends on temperature and size, we can tell a star's diameter by how hot and bright it is.

Color of a star depends on its temperature, varying from blue-white (very hot) to dull red (a chilly 2,000°). If the temperatures deduced from color and spectrum are different, then cosmic dust must be filtering out part of the light before it reaches us.

That is what Dr. J. J. Nassau, who took the accompanying color picture, found in the great Cygnus Rift. The stars there are so dim it was once thought to be a "window" looking into empty space. Comparing colors, Dr. Nassau found excessive reddening caused by a great cloud of cosmic dust, starting 20½ million billion miles out. This makes the stars behind it 100 times fainter than they are. Actually, they are pretty evenly distributed; only the uneven screen of dust makes them seem irregular.

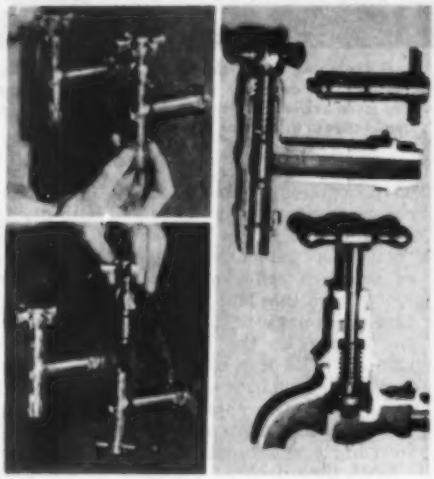
To photograph each of the billions of stars in the Milky Way would be an endless task. Thanks to the Schmidt telescope, we can do it wholesale. The Schmidt, a reflector, covers a wide area, in focus and with plenty of light. The mirror is spherical, removing the "coma" defect that cuts the usable field of ordinary reflectors. Aberration is corrected by a thin lens at the center of curvature. Its image is inaccessible, in front of the mirror, so the Schmidt is used as a camera. With it is teamed the slitless spectroscope. This uses a large, thin prism covering the entire objective to break up the light of many stars at once, instead of just focusing a single one through a slit.

With these improved instruments, astronomers are pushing farther into the Milky Way. Harvard has a five-year plan of Milky Way studies aimed at an accurate map of stars in a 117-million-billion-mile radius. Attention is focused on the center of our supergalaxy, toward Sagittarius. This is overhead in South Africa, so Harvard's Bloemfontein observatory is headquarters for two years of plate making. It is hoped to learn whether the faint red stars in the center clouds are really big, bright giants, highly reddened by a thick cosmic mist, or truly red stars veiled by only a thin haze. Spectra will tell the story—and fill another gap in the Milky Way map. END



Bed Rolls Over

A "SANDWICH" bed for severe fracture cases, who have to be turned over several times a day, has simplified what used to be a difficult and painful process. The bed has a mattress that rotates within a metal frame. When a patient lying on his back needs to be turned over, a second mattress is placed on top of him and fastened by wing nuts at the ends of the frame. Then the bed is turned over and the uppermost mattress is removed, leaving the patient lying on his stomach.



Faucet Doesn't Drip

RESILIENT synthetic washers that can be changed without turning off the water are said to make a British-designed faucet drip-proof. There are two washers instead of the one used in conventional types, and sealing is effected by water pressure. To change washers, the nozzle is removed (top left) and a plug inserted. When the handle and washer assembly are removed (bottom left), the water remains shut off. Cutaways show how the new faucet (top) differs from the old style.

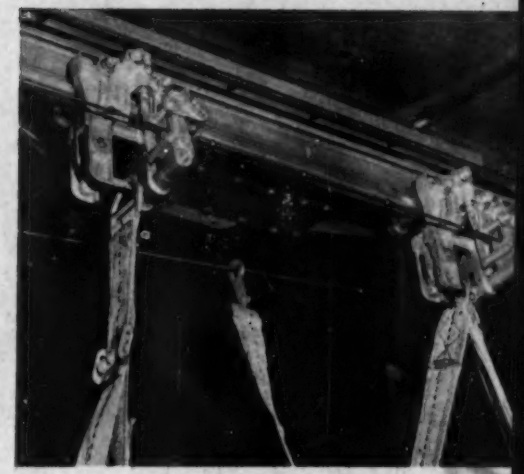
One-inch Wind Tunnel

THE first of two midget wind tunnels being built at the University of California has a test chamber only one inch wide and ⅝ inch high, but it will simulate conditions up to 70,000 feet and velocities up to three times that of sound. Shown above during assembly, the tunnel is so small that only bits of flat metal and wire can be used in tests. The second tunnel will have a three-inch chamber, in which tiny scale models of rockets and other craft can be inserted for testing.

Monorail Speeds Air Delivery

THANKS to a monorail, the AAF can now parachute two howitzers in the time one used to require. The rail runs along the plane's cabin roof; the guns or other loads are hitched to it. At the push of a button, the floor door opens, and the load is automatically carried to it and dropped through.

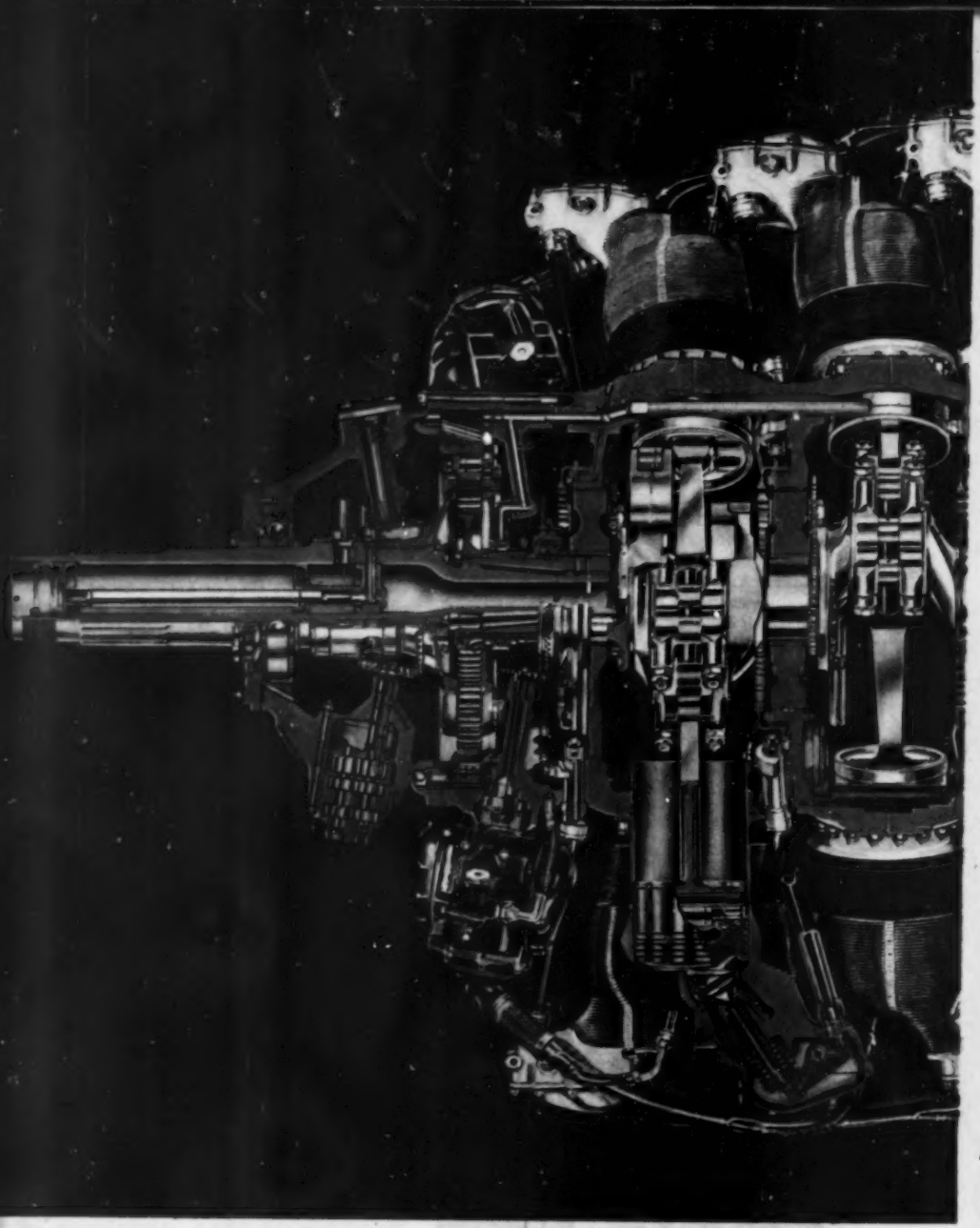
Developed by Fairchild Aviation engineers, the monorail is now under test in a C-82 troop carrier. Fifteen 350-lb. paracans, standard Army containers, can be dropped in eight seconds. Besides this quicker release, pack loading is easier and 50 percent more supplies can be dropped.



The paracans are hung on trolleys pulled along the aluminum monorail by an electrically driven cable. Wire in background is the static line that trips the parachute of each pack as it leaves the plane.

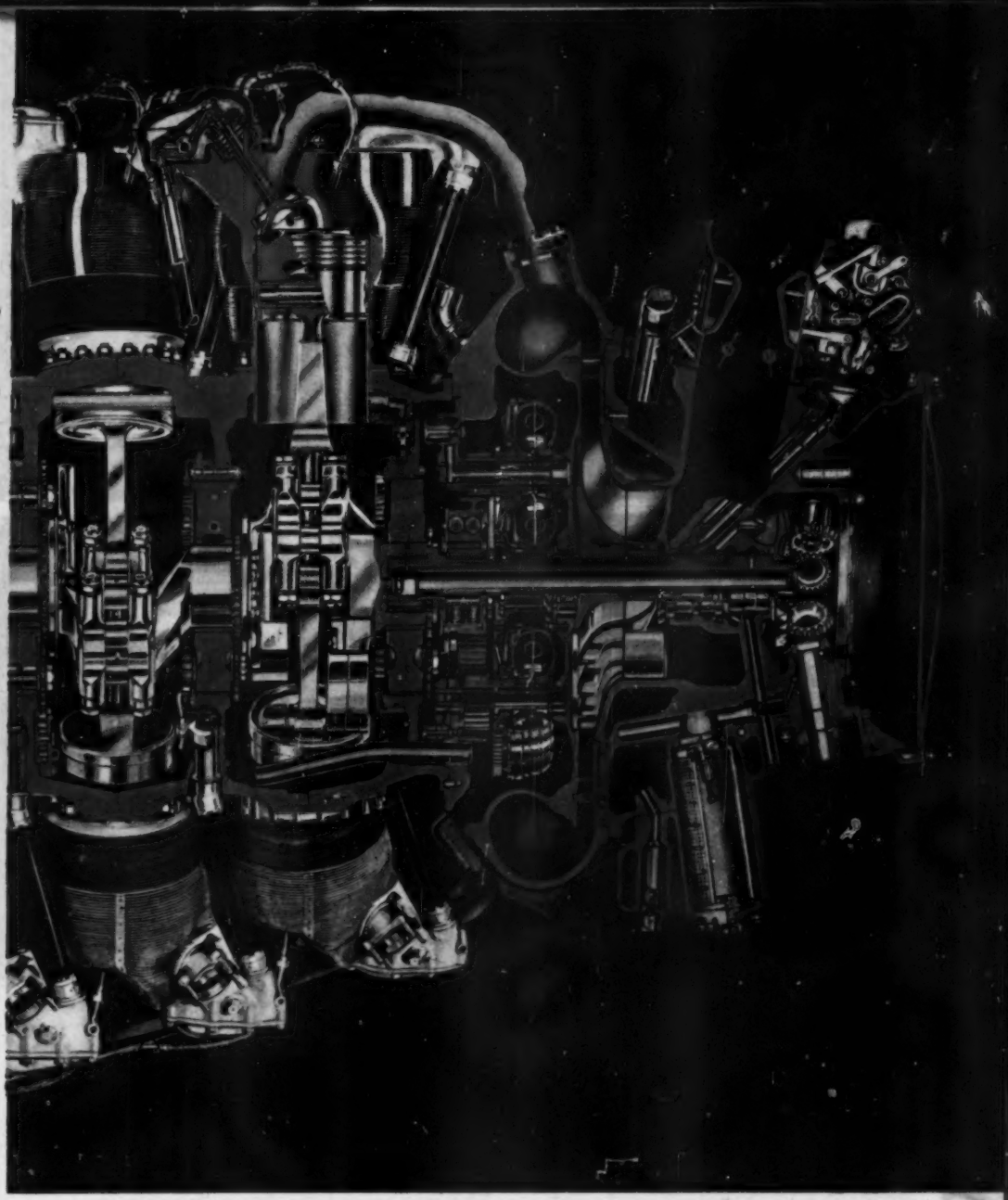
A paracan about to drop through the plane's belly. Others are lined up behind it, ready to go. Static line and rip cords are seen in right foreground.

Paracans parachuting down after a monorail drop from a Fairchild C-82 Packet. Loads are connected by webbing so as to land in a tight pattern.



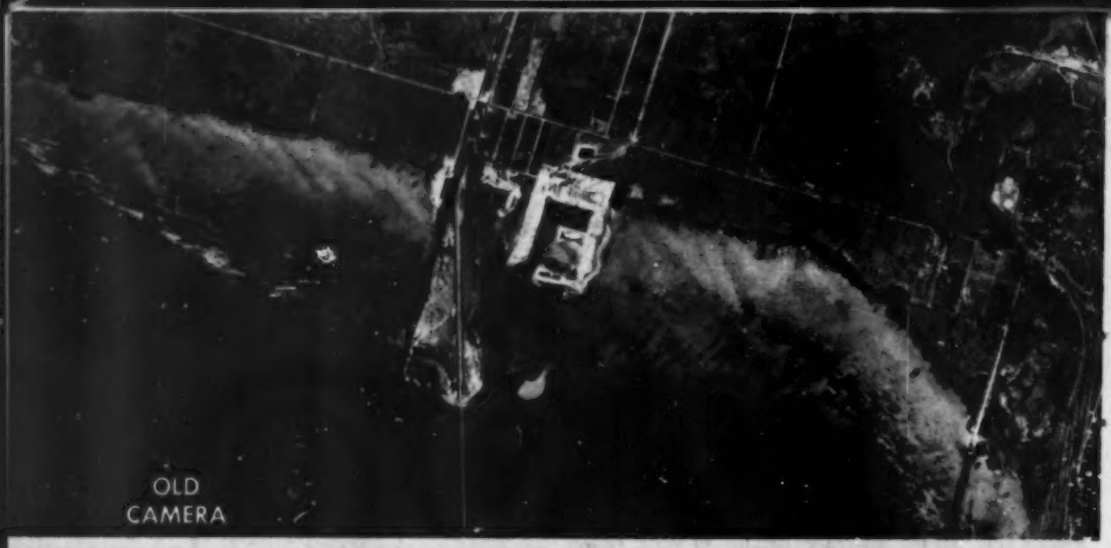
Portrait of 3,500 Horses

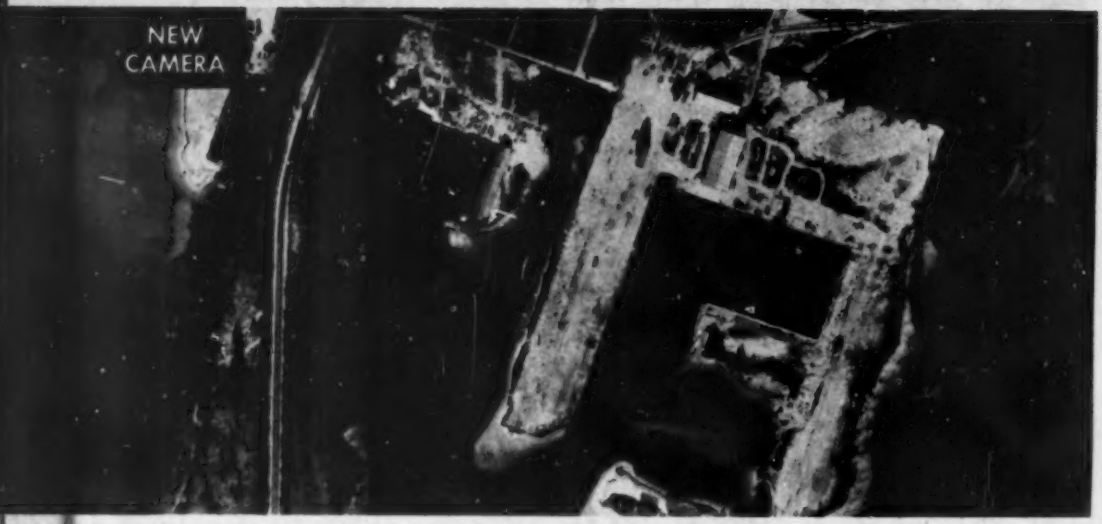
HERE is the inside of the Pratt & Whitney Wasp Major, world's most powerful radial, air-cooled, reciprocating aircraft engine. With the rapid advance of turbine power, this may represent one of the last of the mammoth but compact piston-engine types that began gaining favor with the armed services and air lines two decades



ago. Gradually stepped up from 3,000 to 3,500 horsepower, the Major produces one horsepower per pound of "dry weight." It powers the AAF's six-engine B-36 and will be installed on many of the new high-performance transports.

Crankcase, pistons, bearings, ignition system and elementary parts of the complex gear train are easy to spot in this cutaway. Less obvious is the fact that each of the seven banks of four cylinders is arranged helically around the crankcase, projecting each cylinder into the baffle-guided air stream for cooling. The engine's reduction gears are located at the left, near the splined shaft that holds the propeller. END





A K-30 shot of a Florida beach looks like an enlargement of photo made by a K-18 (focal length, 24 inches).

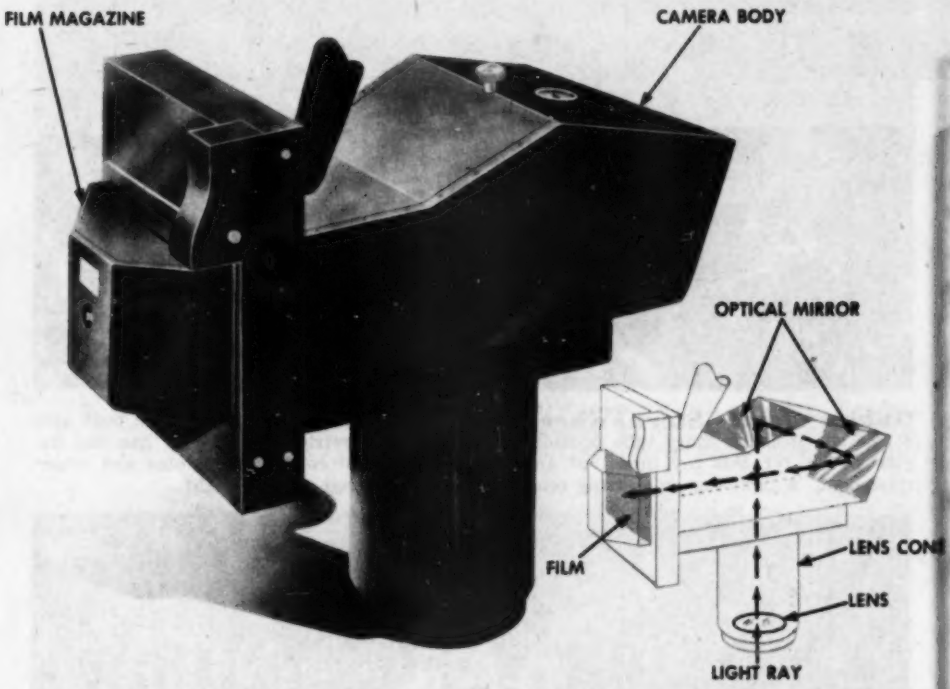
Close-ups from 5 Miles

THE world's largest aerial camera is giving the Army Air Forces a new kind of bird's-eye view—the kind a bird might get with a telescope. Known as the K-30, the camera is a 575-pound giant with an f/10 lens of 100-inch focal length, designed to give 2½ times more photographic detail from an altitude of 50,000 feet than the largest standard camera now used. The comparative pictures on this page show what it can do from 26,800 feet—better than five miles.

Big as the K-30 is, however, a combination of optics and ingenuity kept it far smaller than it would be with standard design, which would require a camera 10 feet tall. By using two mirrors to make an angular light path, engineers held the K-30 to a height of four feet and a width of five feet. Light entering the lens is re-

Its draft seal pushed back for a test run, the big lens looks down out of a B-29's forward bomb bay.

The K-30, shrouded in its protective electric blanket, rises into the bomb bay on a cargo platform.



The drawing and diagram illustrate the camera's construction and show its optically compressed light track.

flected from the first mirror to the second, then to the film, compressing the 100-inch track into a figure 4 pattern.

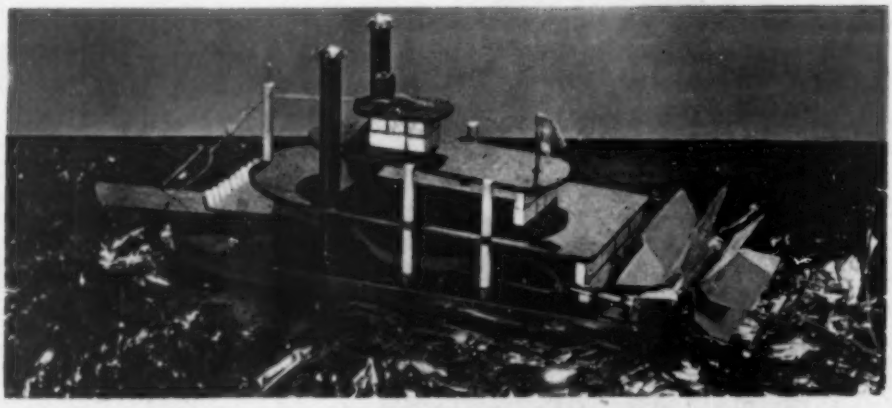
Now being used in high-altitude experiments by the AAF's Photographic Laboratory, the new camera is well equipped for the extremely low temperatures it must meet. It has an interior hot-air circulating system, thermostatically controlled, and a large electrically heated blanket that fits over the entire outside of the camera and lens barrel.

The K-30 has a focal plane shutter, operating at speeds of 1/100, 1/200 and 1/400 second and produces 9- by 18-inch photographs. Its lens, 10 inches in diameter, was especially designed by Dr. James G. Baker, of the Harvard Observatory, and the camera itself was constructed by the Mount Wilson Observatory. END

CRAFTWORK

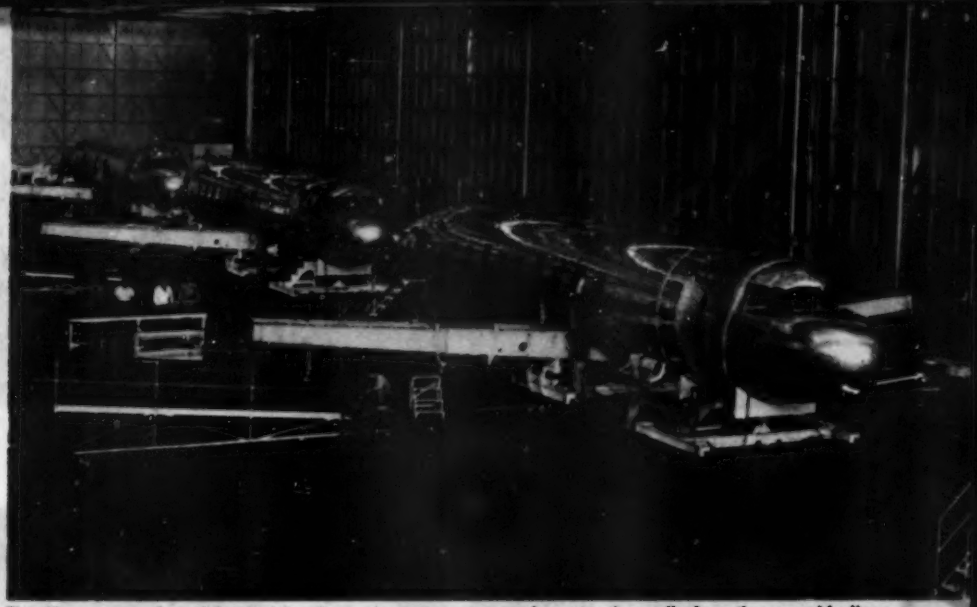
PROJECTS OF THE MONTH

Antiqued Candle Box. Gay designs are painted against a natural pine background, and then antiqued with a thin lacquer glaze to make this box an attractive period piece as well as a convenient place to store candles. Its old-fashioned charm will make it a welcome addition to cabins or cottages where candlelight supplies all or part of the illumination. See page 156 for details.



Rubber-band Stern-wheeler. Strips cut from an inner tube provide engine power for this toy model of an old river boat. A light tug on a string releases the wheel; the string follows the boat and is used to retrieve it when it has run its course. Full construction notes and other photos appear on page 151.

Car-top Catamaran. Canvas-covered pontoons bear this craft smoothly through the water. A sliding, scull-type seat adds leg power to the rower's stroke. It's easily built and quickly knocked down for carrying. Plans are on page 168.



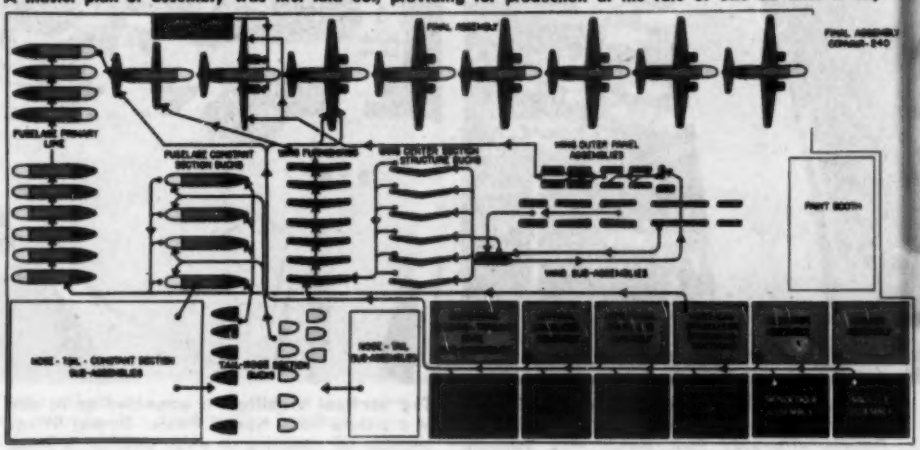
The 40-passenger Consolidated Vultee liners, in various stages of construction, roll along the assembly line.

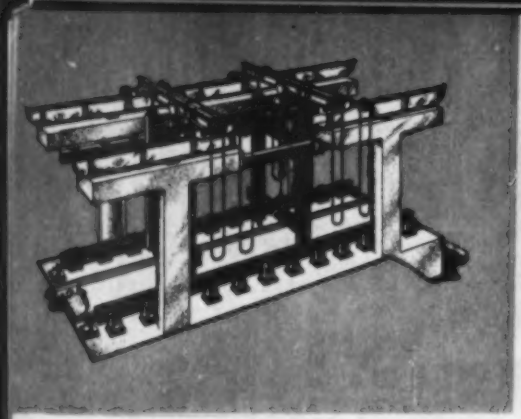
How Air Liners Grow

IT TOOK a war for the aircraft makers to match the auto industry's assembly-line technique, but now peacetime transports are rolling off. The Convair-240, a new 300-m.p.h., twin-engine transport, is constructed of parts so standardized and interchangeable that a dozen planes could be taken apart, scrambled, and reassembled without a single misfit.

The plane's 18 major components are first constructed on permanent, precision-built fixtures and are then brought together for rapid, mass-production assembly. Results: lower cost of production, easier maintenance, faster and more efficient repair.

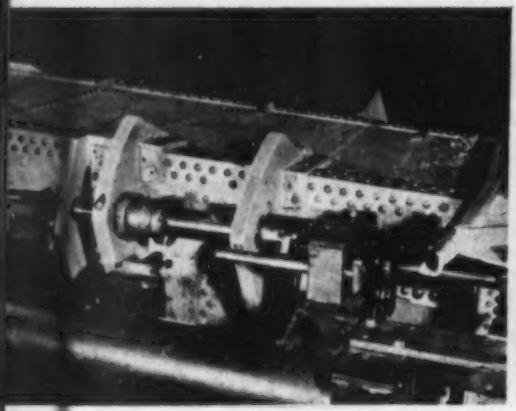
A master plan of assembly was first laid out, providing for production at the rate of one air liner a day.



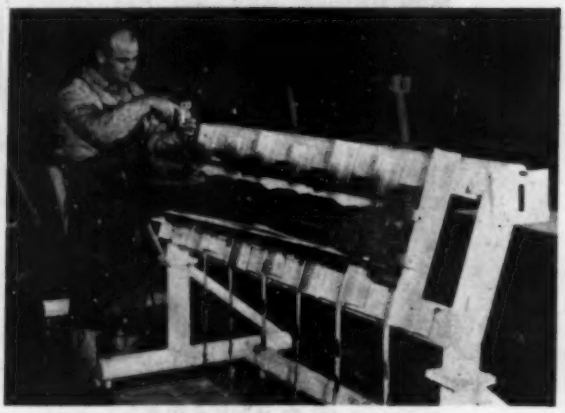


Accurate to 2/1,000 inch, this tooling dock provides precision checking and duplication of fixtures on which parts for the planes are formed.

On long fixtures like the one above, the wing center section spar is assembled. The two side girders form a track for the drill shown in the background.

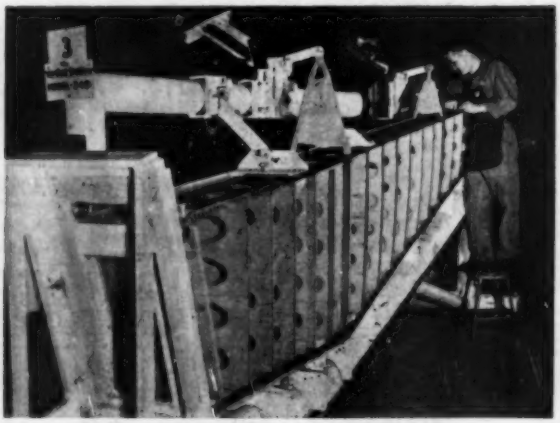


Another wing section fixture locates boring, reaming and other machinery used in fashioning the landing gear and drag-link attachments.

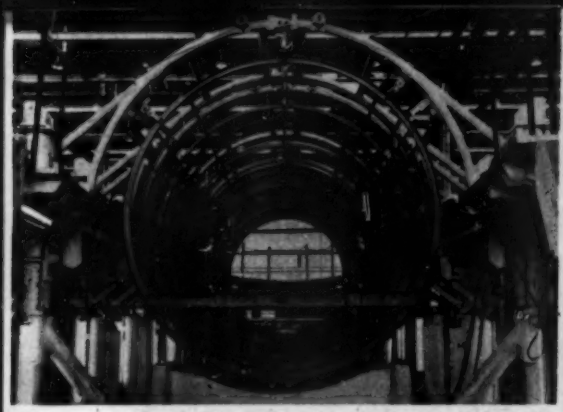


Wing edges are assembled on frames formed of heavy pipe and mounted at a 15° angle. Tooling holes locate ribs and insure interchangeability.

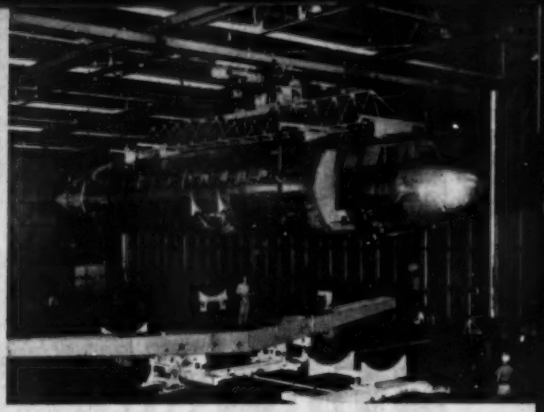
The upper nacelle assembly fixture is built in a vertical position to provide greater accessibility. Nacelle after-body must match wing contours.



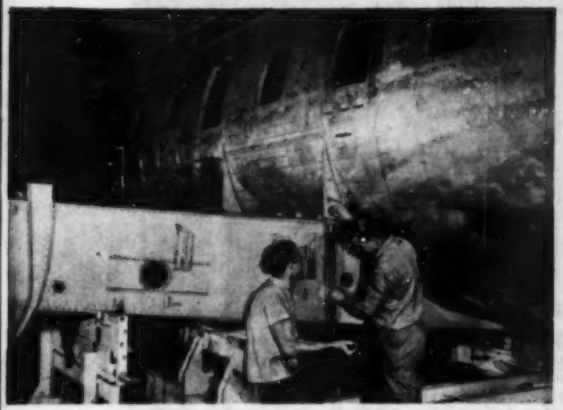
The vertical stabilizer is assembled on its side in a picture-frame type of fixture. Dummy fittings simulate tail mounting on which stabilizer is fitted.



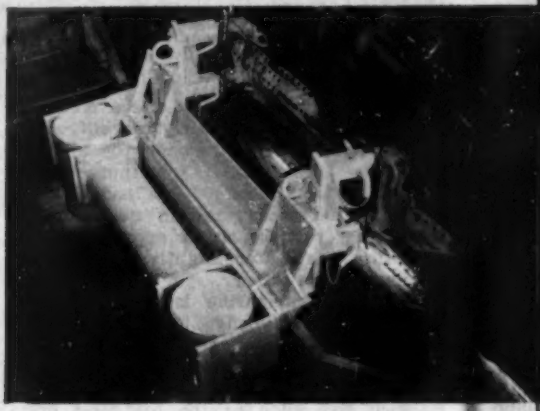
A massive, skeletonlike structure is used to form fuselage and fasten on the nose and tail sections. Full length of fuselage is 74 feet eight inches.



After removal of the parts from their fixtures, a crane lowers the fuselage into position over the wing center section in the first phase of assembly.



A torque wrench, providing exact degree of tightness, is used in bolting wing center section to fuselage. Over-all wing span is 91 feet nine inches.



Precise placement of horizontal stabilizers is assured by a fixture that locates the exact positions of their attachment fittings on the fuselage.

Wing sections, tail surfaces, nacelles and other parts, already built and awaiting installation, are quickly added as planes move down the line.

The finished product. Equipped with two 2,400-hp. engines, the Convair-240 supplements conventional power with jet exhaust for additional speed.

Tub Sub

The toy sub in action, downward bound. Moving the ballast weight on the keel regulates depth of dives.

THE bathtub battle fleet has a colorful new recruit—a plastic "rocket" submarine that performs a series of gliding dives on pill-power. The manufacturer, Payne Products, Inc., of Midland, Mich., supplies effervescent tablets designed to propel the craft for six or seven minutes. Agitating the water slightly makes the submarine dive oftener.

When the submarine is placed under water to start its voyage, the gas-releasing "fuel" acts as a pump, expelling water and sending the craft to the surface. Then it submerges again, and the cycle is repeated. Balance and glide as the toy rises and sinks provide its forward motion.

Superstructure is lifted to expose the power compartment. The white plastic vial is inserted when dry ice is used as fuel, but not when the effervescent tablets are employed. With the two main sections fitted together again and the weight adjusted, the submarine is ready to go.

Toys Run on Compressed Air

DRIVEN by nothing more than air, these two toys can speed along at 15 m.p.h. for 125 feet. The plunger in the rear sends compressed air through tubing to a radial motor, where it is forced out through tiny holes. The released air sounds like a gas engine's exhaust in the racer and makes a putt-putt noise while spinning the rotor of the taxiing helicopter. The toys are made by Mot-Air-Ette, of Chicago.

Courtesy of W. & J. Sloane

There are more machines to pick from now, but even the best have limitations you ought to know about.

How to Choose a Washer

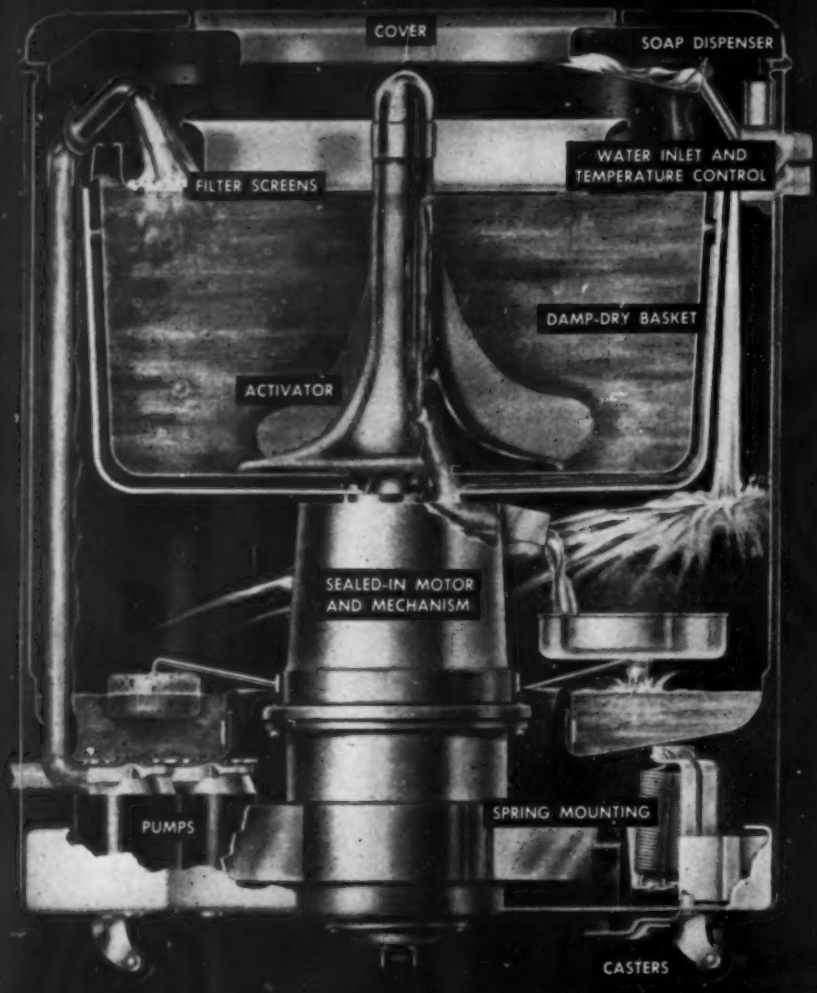
IF YOU wanted to buy a washing machine last year, a clerk put your name on a waiting list; if you were among the 2,023-981 lucky ones, you took the first make he offered you. This year, you may find yourself in a quandary, forced to choose which of several new washers you want.

Like the 1947 cars, most of the washers resemble the prewar models. Several makes with a variety of features are available, but there are still only two major types: the conventional, or nonautomatic washer, with either a wringer or spinner for drying clothes, and the automatic washer that washes, rinses and damp-dries clothes at the flick of a switch.

Without wetting a hand, the user of an automatic can do a nine-pound wash in half an hour, a chore that still takes two hours using the conventional washers, according to time and motion studies.

Of all the automatic washing machines on the market today, however, only three were manufactured before the war, so that automatics are actually still new products. Few changes can be expected in the time-tried wringer-washer, but engineering research for an improved automatic machine is carried on 24 hours a day at most washer factories.

What happens in an automatic washer when the clothes basket is filled with soiled laundry and the time dial is set? The basket revolves in sudsy water, while the clothes are agitated. At the end of the washing cycle, the dirty, soapy water is pumped off. At the same time fresh water is sprayed over the clothes for three complete rinses. The rinse water goes down the drain, and the washer spins a half-mile-a-minute to remove the excess water, leaving the clothes ready to hang on the line. Fi-



Representative of the completely automatic washers, this General Electric machine goes through its wash-rinse-dry cycle in 45 minutes, or less if the operator desires. Manual control permits skipping or repeating any part of the cycle. The rotary damp-dryer turns up to 1,140 r.p.m.

nally, the machine cleans itself, then automatically turns itself off.

Before buying an automatic washer, you should consider your hot-water system and water pressure. Surveys indicate that the weekly wash of the average household is large enough for several washer loads, but unlike the conventional washer—which can reuse the same tub of water—only one load of clothes can be washed and rinsed in the 21 to 28 gallons of water needed for the automatics' operation. To get the most satisfactory results, users of automatic washers need water heaters capable of delivering 40 gallons of water at 140°F. in 80 minutes.

The timers on automatics are adjusted for use with normal water pressure, but recently a suspended timer has been developed for homes with less than 20 pounds of water pressure. This device, attached to the washer, interrupts the current flow to the timer motor, allowing ample time for the tub to fill with water.

Nonautomatic washers are much older, having been on the market since 1874. A washer of this type is usually a portable, vitreous-enamelled tub that contains an aluminum agitator. From six to nine pounds of dry clothes can be placed in the water-filled tub, and a ¼-horsepower motor moves the blades or vanes of the agitator back and forth, swishing the clothes through the water. Some machines have a vacuum-cup arrangement that moves the clothes up and down in the water, thus squeezing the suds through them, but washing-machine authorities agree that the agitator type is the most effective for removing dirt.

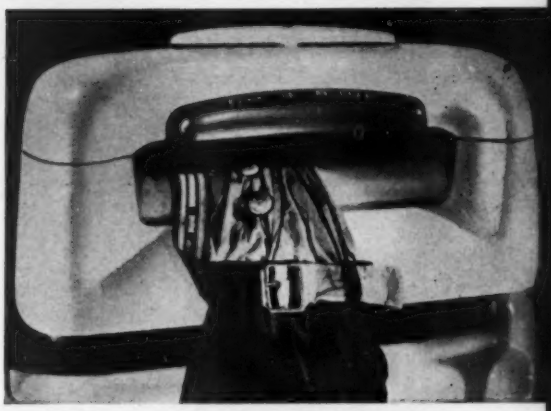
Before buying a washer with an aluminum agitator, make certain that the agitator is easily removable from its shaft for cleaning; otherwise, undissolved soap will corrode it.

No washer equipped with a power wringer can be called "safe" to use. Clothes are passed by hand through the rolls of the wringer, and the 800-pound pressure of the revolving rollers wrings the water out. The Underwriters Laboratories require wringers to have emergency releases that will spring the rollers two inches apart if clothes or fingers are caught between the rollers, but in spite of all the safety releases, the wringer remains a wash-day hazard. Scarcely a day passes that a newspaper doesn't report a washer-wringer accident.

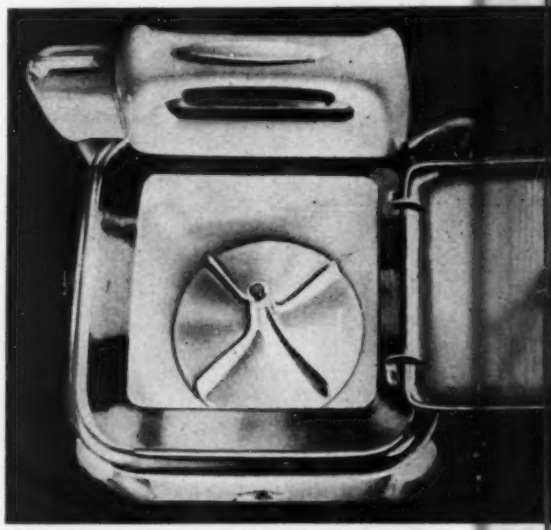
The other drying alternative in the nonautomatic washer is the spinner. Wet clothes put into the spinner basket are revolved so rapidly (about 1,000 r.p.m.) that centrifugal force extracts the water from the clothes. While a spinner may take three times as long as a power wringer to do as good a job (the efficiency of a wringer is rated excellent if water left in the clothes is 72% of the weight of the dry clothes), this disadvantage is offset by the safety feature.

Well-known washer factories are geared to aircraft standards, and some parts of the power mechanism must be accurate to within three to five *millionths* of an inch. As a further safeguard against mechanical failure, some gear cases are assembled with a lifetime bath of oil.

No precautions, however, can protect a washer against misuse, and the greatest number of service and repair calls are for washing machines that have gone out of whack simply because the user failed to follow directions. Your washer is likely to need repairing at least once in its 15-year life. If you place an unmovable automatic well away from the wall to permit easy access on all sides, you won't have the additonal expense of moving the ma-

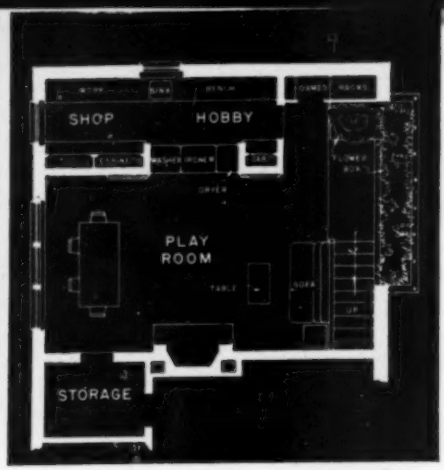


For safety, wringers should have an easily accessible release mechanism, like the bar directly above the rollers of this Maytag wringer. There should also be a device to keep the rollers from turning when the wringer is being swung around. Some nonautomatics use rotary damp-dryers, but cost more.



Agitator type of washer, as illustrated by this Maytag, is considered superior to vacuum-cup machines. Aluminum agitators should be easily removable for cleaning, to prevent corrosion. Hose for emptying washer may have a pump or may function by gravity.

Portable electric washers, for small homes and apartments, take up little more space than a pail. In this one, the motor is built into the cover and drives an agitator; it holds two pounds of wash.



The last word in laundry luxury—a room designed around the washer. This playroom-workshop, suggested by Blackstone, has a washer-dryer-ironer combination that forms a counter when not in use.

chine from its base whenever repairs are needed.

Though clothes are washed cleaner in the present nonautomatics, scientific research should soon produce an automatic washer with a higher degree of washing effectiveness. A problem more troublesome to the engineers is how to develop a more satisfactory dryer in the automatic. A centrifugal dryer rotating fast enough for really effective operation may create large unbalanced centrifugal forces, which could cause violent vibration of the washer and a breakdown of its parts.

While conventional washers and some automatics have casters and can be rolled to the most convenient spot for washing, the automatic machines require special connections, either to the two spigots at a sink or else direct to the water system. Regardless of which type you select and where it is installed, all washing machines should be grounded against shock. Most washers meet the Underwriters Laboratories specifications for electrical safety, but since the laundry floor is generally damp, a good safeguard against shock is to ground the washing machine frame permanently by running a wire from the frame to a water pipe.

Buying a washer is like buying a car—chromium trim just hikes the price. You'll pay extra, too, for features like drain pumps, timers, cord reels and temperature indicators. Because the wringer-type washer is the cheapest (it costs $60 to $120), it continues to outsell the others. Washers with spinners cost about $50 more, and automatic washing machines range in price from $200 to $300.

No matter how efficient your washer is, it will be working under a handicap unless you use enough water and at least two inches of suds. A washing machine will scrub your clothes, but it still takes soap to make them white. END

AC Current Goes Into New Planes

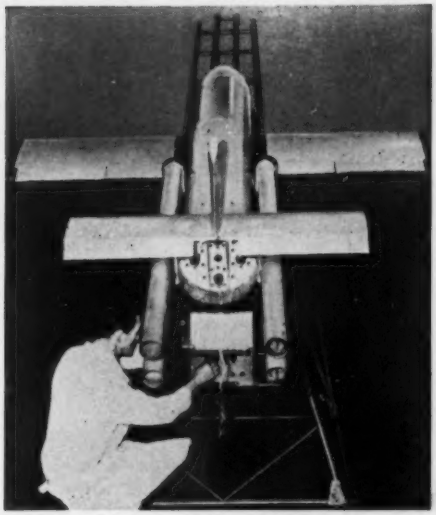
ALTERNATING current, the kind you probably use at home, is going aloft. Experts have found that AC generators give 50 percent more power per pound of weight than comparable DC units. Trouble-free operation is another advantage; with AC, induction motors can be used, dispensing with commutator brushes that wear out rapidly at high altitudes. Westinghouse has designed AC electrical plants for aircraft to be installed on the Consolidated B-36 and the Northrup Flying Wing.

Atoms Track Plant Poison

RADIOACTIVE atoms have turned detective on the track of a killer. A chemical named Inba destroys plants when placed on the leaves. To find out how it slays, radioactive iodine is added to the poison before application. A Geiger counter then traces the course of the deadly compound through leaves and stems. Inba belongs to the same family as the weed killer 2, 4-D. Beans and barley have been impregnated with it in experiments at the U. S. Department of Agriculture, Beltsville, Md.

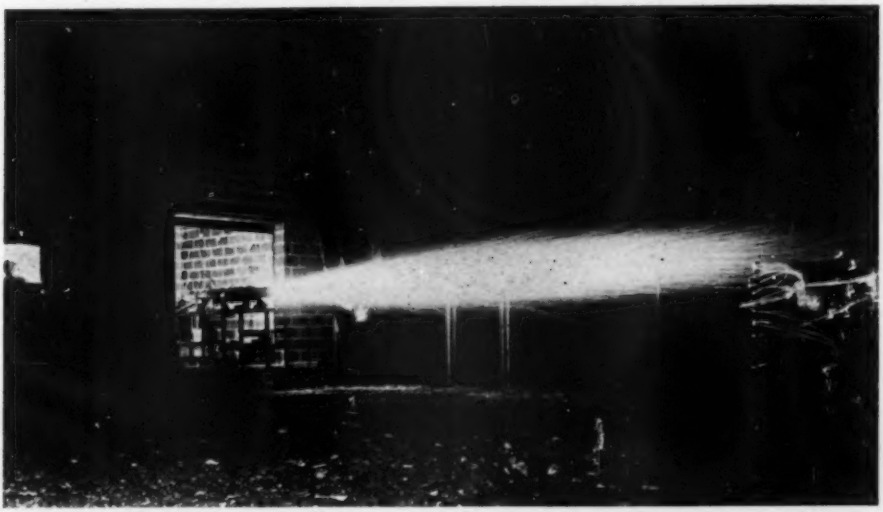
The Loon Takes Off

BOOSTED into the air by four rockets, a Navy KUW-1 buzz bomb roars aloft over the Air Missile Test Center at Point Mogu, Calif. Rockets fall free after two seconds, but the Loon can go on for 150 miles under its own power at speeds above 425 m.p.h.



British Guided Rocket

BRITAIN'S first radio-controlled rocket, developed by the Fairey Aviation Co., has successfully completed its flight trials. Shown being adjusted during a London exhibition, the 7½-foot missile has four main rocket cells, can top 500 m.p.h.

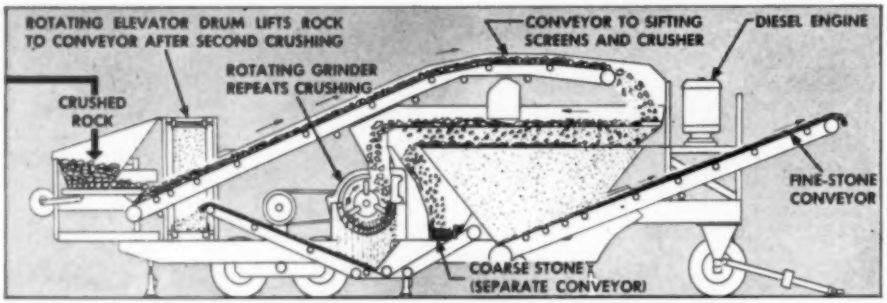


A Ram-jet Shows Off

SPEWING flame from its exhaust, a ram-jet goes through its paces in a night test at the Esso Laboratories, Linden, N. J. Only six inches in diameter, the jet rivals the heat of 300 home oil burners and can travel at nearly twice the speed of sound.

Wrecker Wields a Wallop. Massive walls shatter like egg shells when this new concrete-breaker goes to work, as shown during a demonstration in wrecking operations in war-devastated areas of Greenwich, England. The American-built machine, a one-man mobile unit, has a powerful hammer driven by compressed air.

Monster Munches Rocks. This mobile stone-eating plant chews an 88-ton mouthful in one hour and spits it out in two different sizes. A variable-mesh, double-screen sifter in the main unit, diagramed below, receives broken rock from a primary crusher, separates the coarse from the fine, and gives large fragments a second crushing.



In simulated emergency, experts show use of E & J Resuscitator on "nonbreathing" victims.

Machines that Breathe for You

Portable as a suitcase, they feed oxygen into a maze of tubes and valves to do the work of the human lungs.

By Herbert Johansen

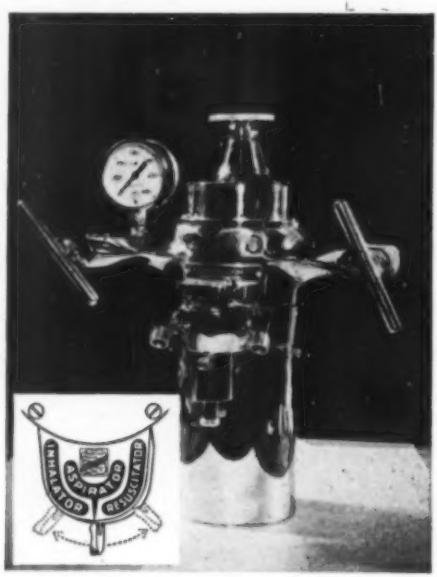
IN YOUR pocket, or on your wrist, is a marvelous little machine that splits time into handy pieces. Your automobile is a whole collection of machines that measure air and fuel, make electricity, pump water, set off explosions, transmit power around corners, and count miles, amperes, degrees of heat and pounds of pressure.

Most of us live, with easy familiarity, in a humming mechanical maze. Few, however, have ever seen—and fewer still have ever experienced—one of man's most ingenious mechanical marvels: a machine that breathes for those who are unable to breathe for themselves.

Not to be confused with a Pulmotor, an iron lung, or oxygen inhalators used in conjunction with manual artificial respiration, the mechanical respirator is winning a battle of breath-taking (and breath-giving) importance in near drownings, explosion disasters, and surgical operations. The machine's versatility was dramatically demonstrated early in its career when a victim of the *Morro Castle* drowned despite his life vest. He was washed ashore, and rescuers pronounced him dead. His wife, who had come through safely, saw her lifeless husband and became hysterical. Solely to appease her, they brought over a mechanical breathing machine and applied the mask.

The machine gave an immediate signal that oxygen was not getting through to the

Complete in its carrying case, the E & J Resuscitator consists of two oxygen tanks, operating head (top center), main breathing mask (center foreground), and two auxiliary micromasks. Panel at left holds infant masks and a test bladder.



Close-up of operating head. Screw on top regulates flow of gas. At left is oxygen pressure gauge. Inset shows the three-way selector valve that permits the machine to be set for resuscitator (breather), aspirator, or inhalator.

lungs: the air passageways were blocked. Removing the mask, they inserted into his throat a tube for removing obstructions, and the machine became an aspirator. The tube was removed in a few seconds, and a small block of wood was found attached to the sucking end. The breathing mask was again applied. With the obstruction removed, mechanical breathing began to take effect. After a while the "dead" man began to breathe for himself. His life was saved.

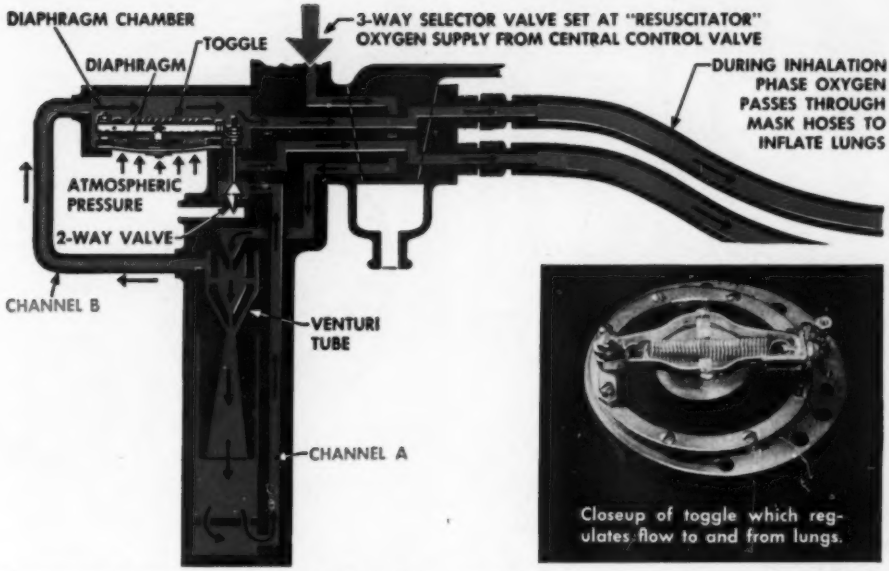
In another case, a worker was overcome by fumes while cleaning out the bottom of a blast furnace. It was some time before he was discovered. When a rescue crew equipped with gas masks reached him, he was not breathing. It would take some time to lift him out of the furnace, minutes that would extinguish any spark of life. Fortunately the emergency crew had brought along their lightweight, portable breathing equipment. The breathing mask was lowered by means of an extension hose and attached to the victim's face. Immediately the machine began breathing for him, and continued to do so while rescuers brought him out of the pit. Even while he was being carried to the dispensary on a stretcher, the mechanical breathing was continued, an operator walking alongside carrying the machine. He lived.

In another recorded case the machine maintained mechanical breathing for a patient whose heart had stopped, allowing the chest to be cut open for manual massaging of the heart muscles that restored life.

The E & J Company, of Glendale, Calif., developed the mechanical lung. It is a resuscitator, aspirator, and inhalator, self-contained in a carrying case 9¾ inches by 16 inches by 27 inches, weighing 41 pounds. Two nine-pound oxygen tanks supply the "fuel" to an operating head. The latter is a catacomb of tiny tunnels inside. A selector valve, Venturis, two-way valves, and a toggle mechanism direct the complicated patterns followed by the oxygen on its various missions and regulate the rate of flow or exhaust through tubes to the mask.

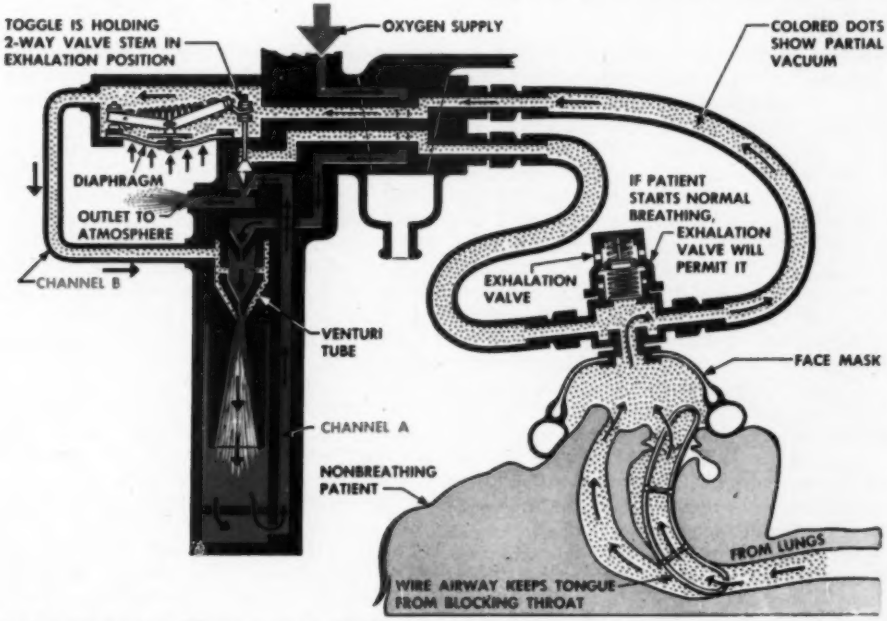
A machine of many parts, it is also a machine of many functions. It balloons the lungs with the required amount of oxygen, but guards against any danger of rupture. It withdraws the used gases but leaves a necessary reservoir. All this is done automatically, according to the size of the lungs, whether used on a baby or an adult.

If oxygen is not getting through, a rapid

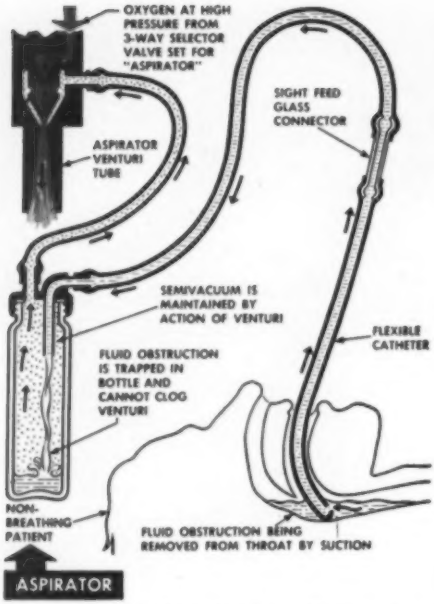


Closeup of toggle which regulates flow to and from lungs.

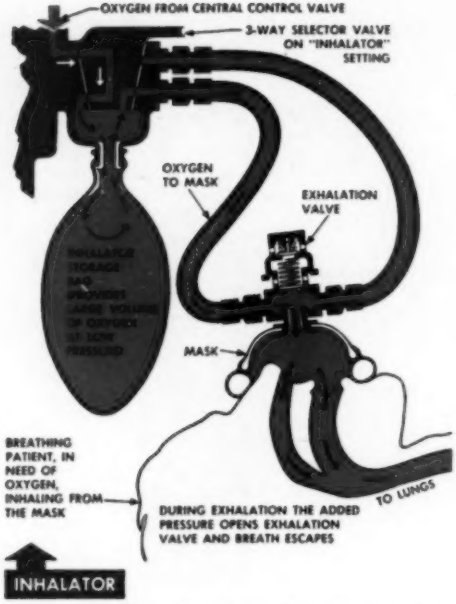
Cutaway of operating head showing first stage of resuscitation. In going past Venturi tube, half of gas follows channel A, half channel B. Latter passes through diaphragm chamber. Oxygen reaches breathing mask via hoses, inflating the patient's lungs. When sufficiently inflated, back pressure depresses diaphragm, acts to trip toggle, starting inhalation phase (see below).



Back pressure from lungs trips toggle, closing upper port of two-way valve, forcing oxygen to speed through Venturi, causing partial vacuum in channel B. Since channel B is now only connection to mask system, gases in the lungs are sucked out through B by way of Venturi to the atmosphere. Negative pressure then causes the diaphragm to rise, reverting to inhalation.



Oxygen rushing through separate Venturi causes vacuum to activate the aspirator. Obstructing fluids are sucked from the patient's throat by means of a catheter, deposited in glass bottle.



In case nonforced oxygen flow from main head is inadequate, storage bag provides an ample reservoir. A safety valve prevents the machine from interfering with patient's own breathing.

clicking warns the operator that the air passages are blocked. A flip of a switch turns the machine into an aspirator, and a sucking tube inserted into the throat removes the obstruction.

At the first sign of natural breathing, another signal, a violent irregular clicking, gives the news. Another quick flip of the switch stops the mechanical breather and allows the patient to inhale the required amount of oxygen for himself and to exhale through a flutter valve in the face mask.

Ingenious auxiliary micromasks can be plugged in, enabling the machine to be used on three people at once. Each mask is independent of the others; one can be resuscitating, another sucking out throat obstructions, while a third supplies oxygen for a man who has begun to breathe.

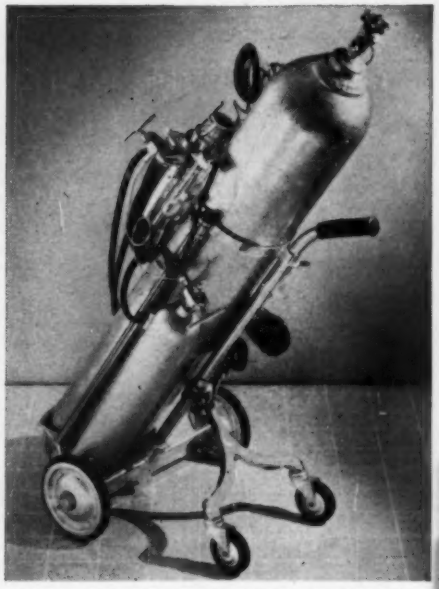
Mechanical breathing had one great obstacle to overcome. Because lungs vary in size, there was always the danger of rupture. In fact, for many years medical men said that it would be not only harmful but impossible. The problem was solved, however, through an ingenious pressure-activated mechanism.

After leaving the storage bottle, oxygen pressure is reduced; then for the resuscitation (mechanical breathing) operation the oxygen flows to the patient via a connecting hose and breathing mask. When the oxygen flow builds up a positive lung pressure of 13-mm. mercury, an equal pressure builds up in a toggle chamber, tripping a switch that closes the flow channel and opens an exhaust passageway. This activates a vacuum action, withdrawing used gases from the lungs until a negative pressure of 9.75-mm. mercury below atmospheric pressure reverses the procedure, opening the oxygen flow again.

Thus, in the case of a baby's small lungs, very little oxygen is required to raise the pressure to the positive high. The larger the lung the larger the flow of oxygen and withdrawal of gases. Thus the size of the lungs actually regulates both flow of oxygen and exhaust of gases.

The arbitrary high and low pressures were determined after research to insure sufficient flow and withdrawal from all sizes of lungs. Tests also proved that these pressures bring about a near-normal respiratory rate in patients ranging from a new-born infant to a six-foot fireman.

Close-up of the auxiliary micromask that enables the machine to be used on two or three persons simultaneously. Plugged into the main head, it is independent breather or inhalator.



Folding fork wheelbase of this portable hospital model enables a nurse to handle easily a 130-pound oxygen cylinder by herself. Complete E & J unit is attached to side of the cylinder.

Asphyxia is suspended animation due to a deficiency of oxygen and an excess of carbon dioxide in the blood. Nature has provided a reserve supply of practically everything the body needs except oxygen. The only reserve oxygen is that in the blood plus a small amount in the air in the lungs, barely enough to sustain life for 10 minutes. When a person stops breathing and this reserve supply is exhausted, certain cells of the body begin to degenerate. This is particularly serious in the brain cells, which never recover once degeneration has set in.

Speed is therefore essential in applying some sort of artificial respiration. The simplest and oldest method dates back to the days of Elisha the prophet. He restored the life of a Shunammite boy by blowing his breath into the mouth of the child, thus forcing oxygen and carbon dioxide into the lungs under pressure.

Of the manual methods, the best known and most widely used is the Schaefer prone system. Others are the Silvester method, used by the Coast Guard, and the Eve rocking method used on British battleships (PSM, July '46, p. 103). An oxygen inhalator, of course, can be used with these.

Successful application of manual artificial respiration, however, depends to a great extent on the retraction of certain muscles to give diaphragm action. Where a person has ceased to breathe altogether, or is breathing very poorly, this essential muscle tone is not present.

Here is the advantage of a mechanical breather. Entirely automatic, it requires no muscular or other response from the patient.

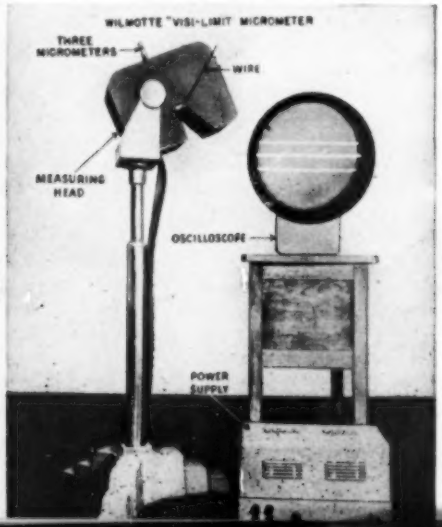
This is not a disparagement of the manual methods, which should be resorted to immediately where mechanical apparatus is not available, or until it arrives. *Speed is essential in all cases of asphyxia: a minute or two lost can and has cost lives.* Fortunately today most public and industrial emergency rescue squads and many beach patrols are equipped with the mechanical breathers.

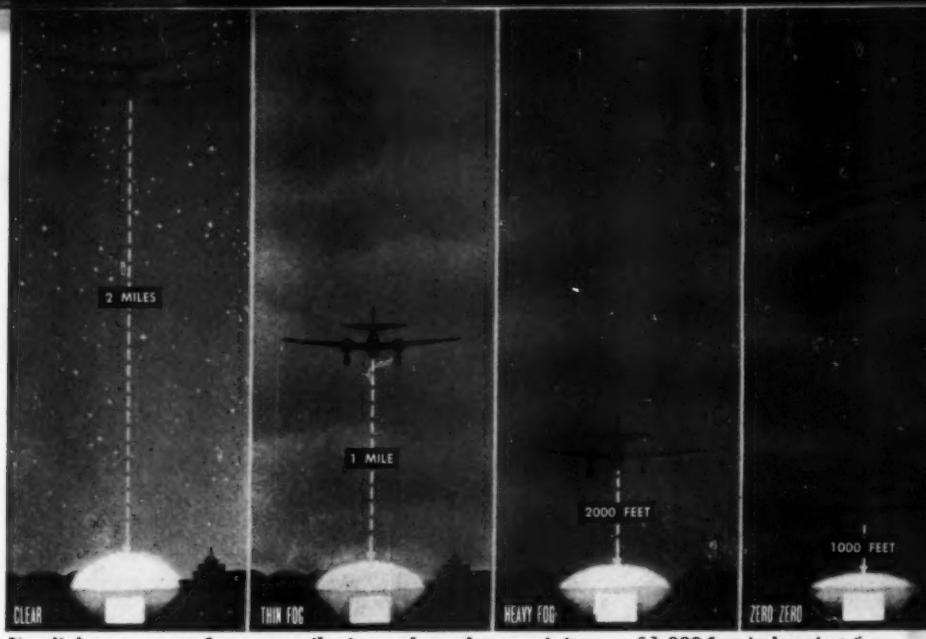
Some years ago, when there was still a question about the safety of mechanical breathing equipment, an eminent physician investigated its merits. As a final test he donned the mask of a breathing machine and for 15 minutes let it "breathe" for him. Then he began his report: "If mechanical breathing didn't work, I wouldn't be here to write these words . . ." END

Light Aligns Wheels. Faulty wheel alignment, often the cause of steering difficulties and rapid tire wear, can be easily detected by the Visualiner, an outgrowth of wartime light-beam gauges. When a car is driven onto the checking ramp, light beams projected on a chart clearly indicate the alignment of the wheels.

Tearing Turbine Fuel Apart. To get more power from an oil-burning gas turbine designed for possible use in locomotives, Westinghouse has devised a new nozzle that blasts heavy oil into particles only 4/10,000 inch in diameter. The nozzle, shown below (right) in a comparative test, causes six fine streams of air to collide with incoming fuel. This miniature cyclone sprays oil into the turbine combustion chamber in a mist 10 times finer than that of old-style nozzle (left), improving combustion and boosting power.

Measuring by Shadows. Checking dimensions to within 2/10,000 inch by the shadows they cast, the new Visi-Limit electronic micrometer can speed the production of wire, tubing and similar materials. A scanning disk sends a light beam to three apertures in turn—maximum, minimum and test—and a photocell picks up the flashes and transmits them to a cathode screen. There they appear as three horizontal lines; as long as the middle line remains between the other two, the required tolerances for the item tested are being met.

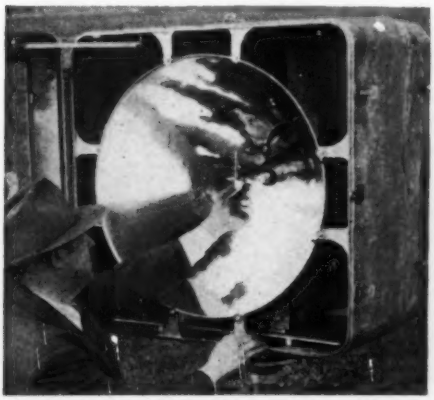




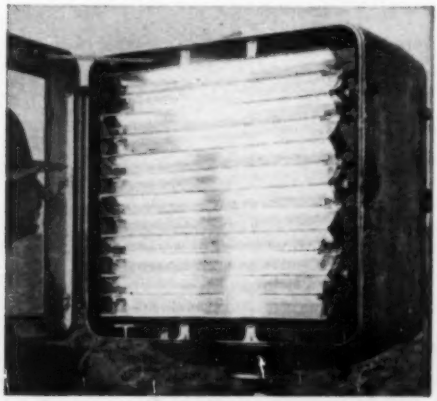
New lights penetrate from two miles in good weather to minimum of 1,000 feet in heaviest fog.

Big Flash Aids Fliers

A LINE of 36 of the world's brightest lights, equal to more than 1,800,000,000 60-watt bulbs, will enable pilots to make visual landings despite the thickest fog. Each of 3,300,000,000 peak candle power, these krypton lights are combined with neon blaze units to throw up lightninglike flashes. These penetrate at least 1,000 feet up through any weather to tell the pilot, who has made a radio or instrument approach, when he is lined up with the runway. As he comes down, a green arrow shows him when the runway is clear; a flashing red cross tells when it is blocked. Other lights outline the runway itself. Westinghouse developed the system, now under test.



Source of "bottled lightning" in this unit is four-inch quartz tube filled with krypton gas. It is the key to fog-penetrating landing lights.



Thirty-six of these neon units are used alternately with krypton lights to create lightning effect; can be used alone in clear weather.

Color Tele Goes Big

Color projector contains three monochrome kinescopes. Inset shows one with its associated optical system.

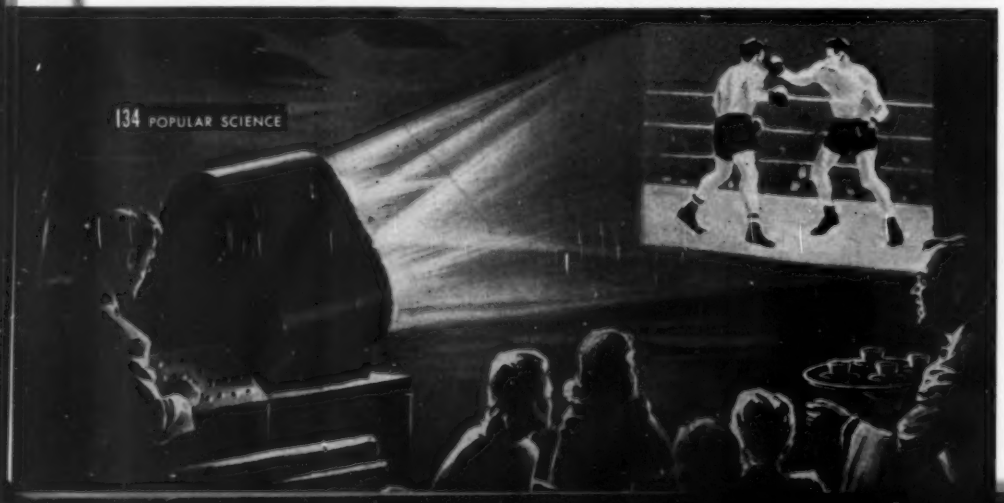
COLOR television that can be projected on a large screen is the latest achievement of RCA engineers. At a demonstration in a large auditorium, color images were received and shown on a 7½- by 10-foot screen. The new receiver-projector utilizes the all-electronic system of color transmission (PSM, Feb. '47, p. 100) in which three separate images in red, green and blue are sent out simultaneously over adjoining channels.

At the receiver, each image is picked up by a separate kinescope and focused onto a concentric mirror that reflects the picture back to the screen. Correcting lenses compensate for mirror distortion, so the three pictures reach the screen in proper focus and proper register.

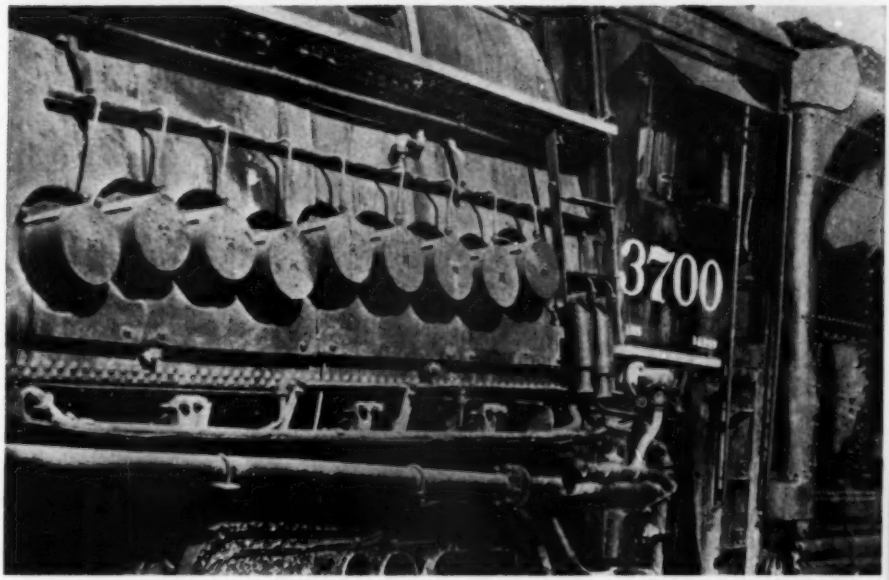
Although color and picture quality are good, images do not have the brightness and definition achieved by black-and-white receivers. RCA experts say several years will be needed to bring color television up to present monochrome standards.

Because of the cost of three-part receivers and the delicate optical system necessary when using large-screen equipment, the new system is better suited to industrial plants and theaters than the home.

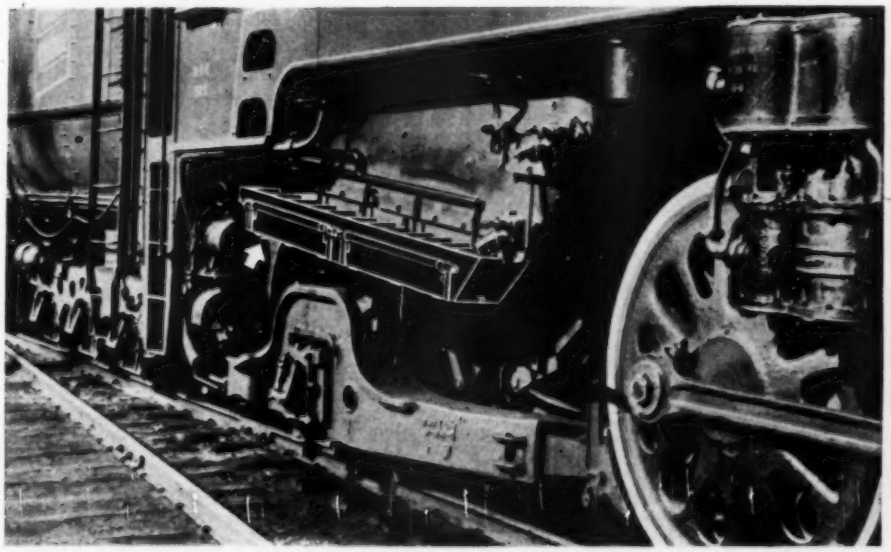
In a few more years restaurants, clubs, and the like may put large-screen color television on the menu.



Oxygen for Locomotives



Mountain-climbing steam engines on the Denver & Rio Grande Western Railroad are "breathing" more easily now with the help of supplementary supplies of oxygen when the natural content in the air begins to thin at high altitudes. Fed into the engine's firebox through a number of intake ports in its side, the oxygen increases combustion and thus provides maximum power.



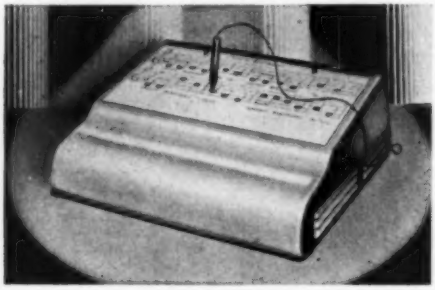
Better circulation of air is the object of another locomotive aid now undergoing road trials on several U. S. railways. Mounted along the ventilation ports under the firebox, the device (arrow) consists of parallel vanes that scoop in the air and channel it evenly to all parts of the grate. This, too, results in greater combustion and lower fuel consumption.

AIDS TO MODERN LIVING

JIGGER SAVES LIQUOR. Designed to rest across the top of the glass, this 1½-oz. clear plastic jigger lessens the possibility that any liquor will be wasted by accidental spilling for, when full, it can be emptied directly into the glass below. The jiggers are injection-molded of polystyrene. They are being distributed by Akret Products, New York.

PLASTIC BIKE PUMP. The Pharis Tire & Rubber Company, of Newark, Ohio, produces plastic bicycle pumps in color combinations to match the grips, horn, and other accessories of a bike. When not in use, the pump may be clamped to the bicycle, with its short length of hose detached and stored neatly inside the plastic head of the pump.

THROW-AWAY FLASHLIGHT. Sealed inside transparent plastic, a tiny flashlight made by the Falge Engineering Service, Bethesda, Md., is intended to be discarded after its one cell is dead. Pressure on the plastic cover operates a switch. Produced primarily to carry an advertising message, like a packet of book matches, the lights are offered only to advertisers, in quantity lots, at a cost of approximately 26 cents each.

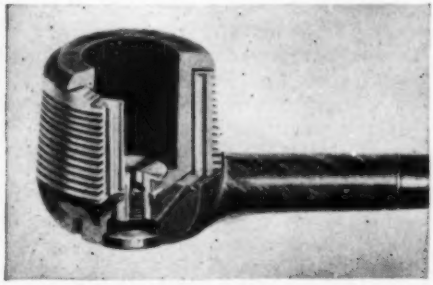


MUSIC PLAYED BY TOUCH. Designed as an educational toy, an electric xylophone introduced by Barr, Inc., of Rockford, Ill., produces a tune when a pointer is inserted in holes constituting the notes of special music sheets. Each contact closes a low-voltage circuit, energizing a solenoid and causing a glass tube to be struck. The instrument has nine notes, and operates on A.C. only. Six music sheets are available.

LIQUID TIGHTENS JOINTS. A liquid marketed by the Chair-Loc Company, of Freeport, N. Y., is designed to tighten loose wood joints. The manufacturer reports that it may be used for such jobs as securing tool handles and legs of furniture without taking the loose joints apart, the liquid locking the joint by swelling the wood fibers.

SHORT RAIN JACKET FOR SPORTS. A short plastic rain jacket for golf and general sports wear is offered by the Whitewater Raincoat Company, of Whitewater, Wis. An opening under each armpit allows air to circulate freely inside the loose-fitting garment and keep the wearer comfortably cool. Colors are clear, brown, and gray.

BULB GIVES INDIRECT LIGHT. With a 200-watt bulb introduced by Sylvania Electric Products, Inc., of New York, an ordinary floor lamp may be used for indirect lighting. The top of the bulb gives upward diffusion, while the lower part provides diffusion of light on reading surfaces. Any lamp can be adapted for the bulb by removing the existing wire lampshade support and substituting a new support that snaps over the bulb.



PIPE COOLS THE SMOKE. In a new pipe made by Erskine-Mills Company, Elizabeth, N. J., the smoke travels through 34″ of looping aluminum channels. Smoke thus channeled is said to undergo a radical drop in temperature, and tars and resins are condensed out. The bowl may be turned to an "on" or "off" position, the latter being used when lighting the pipe to allow the smoke to bypass the cooling channels.

GUS Earns an Assist

By Martin Bunn

HAM CARR braked his old red sedan to a smooth stop on the Model Garage's shop floor and stepped out nimbly. "Hi, there, my friend," he hailed Gus Wilson. "Got time to give this old bus the once-over?"

"Sorry, Ham," Gus said, shaking his head. "Not today. I've promised this job I'm on, and I won't have it finished until quitting time. But Stan Hicks will be back soon. He can check if that suits you."

"Sure, that will be O.K.," Ham agreed readily. "The old gal's running all right, so I guess there's nothing wrong except what you'd expect from old age and a hard life. But I've got to drive her fast for a couple of hundred miles tomorrow, and I want to be sure she can take it. Going to the ball game in Millville?"

"I'll be there," Gus grinned. "Even if I weren't a fan myself, I'd have to on account of Stan. Since he's been playing right field for the Stags he doesn't think or talk anything but baseball. He's just killing time working for me until some big-league scout comes along and signs him."

Ham is promoter and manager for our town's crack semipro club. "Stan's no big-league prospect," he admitted, "but he's always in there trying—and he sure loves baseball. I wish some of my other players were that way—Buzz Bentz, for instance."

"What's the matter with Buzz?" Gus demanded. "He's won every game he's pitched this season. What more do you want?"

"There's nothing wrong with Buzz's pitching," Ham agreed. "It's his attitude that gets my goat. The Reds were after him when he was pitching college ball, but he wouldn't even talk to them—wanted to be a chemist! Now that he's in the National plant he doesn't mind picking up 25 iron men from me once a week, provided it doesn't interfere with his test tubes. But he doesn't have his heart in the game."

"What do you care," Gus retorted, "as long as he's good for a win every start?"

"He's driving me nuts," Ham complained. "Right now, the day before the big Millville game, what do you think he's doing? Taking care of his arm, practicing his drop?"

The manager stomped in disgust. "Naw!" he answered himself. "He's winding up his vacation from the plant—teaching a short summer course in chemistry at the college in Madison. I'll bet he hasn't had a baseball in his hand the entire two weeks. And he won't leave a minute before the noon whistle closes his last class tomorrow. I've got to be there with my car to rush him to Millville. That's why I want it checked."

Gus did a little quick figuring. "You can't make it," he decided. "It's 140 miles from Madison to Millville. You haven't a chance of doing it in two hours and a half."

"I don't expect to," Ham winked wisely. "But that's all right. Lank Jimson can hold Millville for three or four innings. He's good,

but he's got no stamina. Before he tires, I'll have Buzz there to relieve him. Get it?"

"So that's it," Gus laughed. "Well, here's Stan. Tell him about your car, Ham."

GUS had planned to start for Millville by two o'clock. But when he got back to the shop from lunch at half past one, a new customer came in with a car that wasn't running right despite an expensive engine job down in the city. It was a tough nut trouble-shooting job, and Gus got so interested in it that he forgot all about the ball game. When at last he had found the cause of the trouble and pointed it out to the customer, he glanced at the shop clock and saw that it was past three.

"Holy cat!" he whistled. "I've missed most of the game. Stan will never forgive me if I'm not there for the last inning. Bring your car in Monday, mister, and I'll finish the job then. I'm doing a fade-out for Millville."

He was quick at washing up and changing from his coveralls, but it was going on four when he left the shop and pushing the hour—with almost 20 miles to Millville—when he drove through the intersection at which the Madison road joins the highway.

A couple of miles beyond, Gus saw a familiar red sedan standing on the shoulder, and when he got closer he recognized the man who was pacing impatiently up and down beside it with his eyes on his wrist watch—Ham Carr. Just as Gus was pulling up behind the sedan, Ham jumped into the old bus and drove off in a swirl of dust.

Wondering why Ham was so late and what he had been waiting for, Gus kept close behind. In 10 minutes the car slackened speed, pulled to the side of the road, and stopped. Gus stopped behind it and jumped out. So did Ham, his eyes again on his watch.

"What's the matter?" Gus shouted.

"My bus has gone nuts, and I'm going nuts, too—that's what's the matter," Ham sputtered. "Those Millville murderers must have slugged Lank Jimson off the mound by now. This is awful!"

"What's wrong with the car?" Gus asked.

Ham kept his eyes on his watch. "It's gone nuts, I tell you," he repeated bitterly. "For 10 minutes it runs swell; then it won't run at all for five. Then it will run swell again for 10 minutes. It's been doing that all the way from Madison. This is driving me crazy! And look at that Buzz Bentz—he's asleep. What an attitude!"

Gus peered into the sedan. Buzz, in his baseball uniform, was slumbering peacefully on the rear seat. Gus shook him.

"Wake up—wake up!" he said. "Get out and get into my car. Leave your bus here, Ham, until after the game. Maybe we can still get there before it's over."

Gus is always known as a careful driver, but when he has to make time in his old well-kept coupe, there's nobody on the road

who can beat him. As they drove up to the players' gate under the old grandstand, a thunderous roar let them know that the game was still on. They ran through the deserted dressing room and onto the field.

An anxious glance at the scoreboard told them that the Stags were ahead 4 to 2 and that there were two men out in the last half of the ninth. But on the diamond, there was a man on third and another on second. Lank Jimson, weary and shaky, was set for the pitch. He didn't see Buzz arrive, and he didn't see Ham signaling frantically for him to throw wide.

Crack! Ash met horsehide, and a hard-hit Texas leaguer went out over the infield between first and second. It reached Stan Hicks in right field on its stinging first bounce. The grease monkey threw almost as he caught the ball—with one clean motion. It was a beautiful throw straight for home plate. In that split second allowed him, Stan realized he would never catch the batter at first, and he threw home in a prayerful effort to keep the tying run from scoring. It worked. The man on third slid home with yards to spare, but the second runner was held on third though the batter stretched his hit to a double.

Then Lank, his shoulders slumped with fatigue, went slowly to the showers. Buzz walked briskly to the mound amid the howls of the stands and with Ham's final plea in his ears. "Get in there and *pitch!*" Ham had whispered hoarsely. "There's an extra 20 bucks in it if you fan this guy."

This guy was Hank Watson, Millville's heaviest slugger, and the Stags' lead had been clipped to one small run. The tying run was on third, the winning on second.

Hank stood back nonchalantly, exuding confidence, as Buzz wound up deliberately and put his first warm-up pitch straight through the center of the plate into Bill Greely's waiting mitt. The roar from the stands gave way to tense silence. Only Buzz—and Hank—seemed unconcerned. There was a second pitch, a third, fourth, and finally a fifth.

Then Hank stepped into the batter's box, heaving aside two bats as he did so and retaining his old reliable favorite. He dug the spike on the ball of his left shoe into the earth and brought his bat slowly back on his right side. Bill signaled, and Buzz nodded assent. He fingered the ball behind his gloved hand, glanced swiftly at the runners on third and second, and threw. "Strike one," called the umpire. The stands kept strangely still.

Hank let the next three pass without moving a muscle—they were balls. The next he fouled over the stand just inside the third-base line. Three and two.

Even as Buzz's arm flashed on the next pitch, the runners on second and third were in motion. Hank stepped forward, intending to meet the ball before it could break, and swung with all his weight.

That was all. For Buzz broke his drop a little faster than usual, and Hank missed by inches. Millville's section of the stand groaned, and ours went wild. Buzz, calm and cool, walked off the field.

WHEN a semblance of quiet had been restored in the Stags' dressing room some 30 minutes later, Gus hunted out Buzz and Ham.

"Great pitch," he told Buzz as he clapped him on the back. "What did you put on that ball, anyway? But let's get going back to Ham's car. The highway ought to be pretty well cleared, and we can make a road test."

When they reached Ham's parked car, Gus wanted to know whether it gave any warning before it pulled its crazy stops.

"It sputters a little," Ham revealed.

Gus raised the hood. "Drive with this up," he instructed Ham, "and stop quick as soon as you notice the sputter."

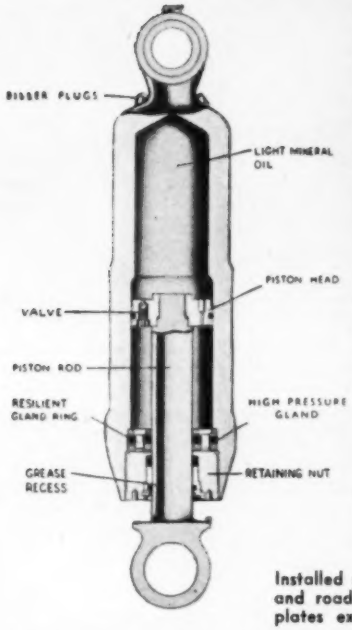
At the end of nine minutes, Ham braked. Gus, coming up behind, went over to the sedan. As it gave its last cough, he heard the whiplike snap of a high-tension spark.

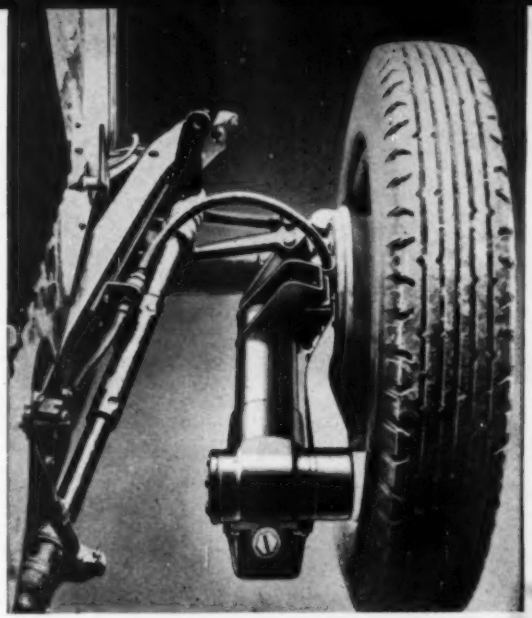
"This is anticlimax after the excitement of that ball game," Gus laughed. He pointed to the high-voltage lead that runs from the coil to the center of the distributor cap, which on Ham's car was close to the manifold. "See where the insulation has worn off?" he asked. "When that comes in contact with the manifold it causes a short."

"But how . . ." Ham started.

"Copper wire expands, lengthens in this case, with heat," Gus explained. "When the wire is cool it's almost straight, but when it stretches out it curves and touches the manifold. That causes your trouble. We'll tape up the bare spot and put in a new lead Monday. Even if Stan didn't notice it when he checked your car, he played good ball."

"So did you," Ham grinned. "If you hadn't come along when you did, Gus, Buzz would never have got there in time. In my scorebook you get credit for an assist." END





Installed on cars, a new liquid spring is said to improve riding comfort and roadability. A resilient gland ring sandwiched between two steel plates expands under pressure and keeps the oil from leaking out.

Liquid Springs Take the Bumps

COMBINING the functions of both spring and shock absorber, a revolutionary new hydraulic spring developed in England during the war provides riding comfort through actual compression of a liquid. Produced originally for aircraft undercarriages, it now is being developed by Dowty Equipment, Ltd., for motor vehicles, railway rolling stock and industrial uses. The Gabriel Co., of Cleveland, has obtained the right to manufacture it in the United States.

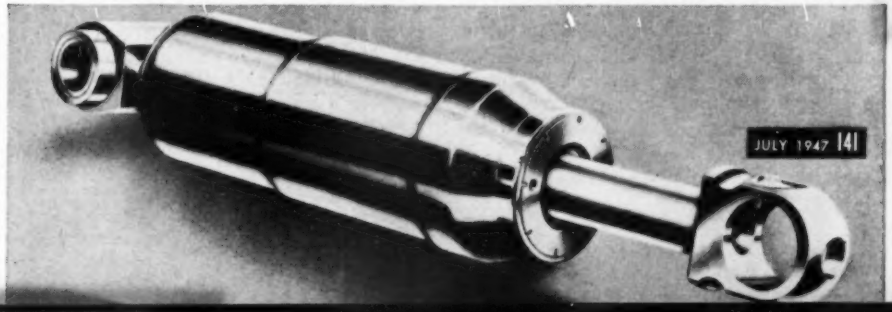
The liquid spring refutes a common belief that fluids are not compressible. Tests have shown that the light mineral oil used in the spring is compressed 20 percent under a pressure of 60,000 lb. per square inch.

Basically the hydraulic spring consists of an oil-filled steel cylinder containing a piston that carries a valve. A rod attached to the piston emerges through a high-pressure packing gland that seals the cylinder and at the same time permits smooth action of the rod. Under pressure, a resilient ring in the gland assembly tends to expand into the cylinder, providing a seal around the rod and keeping oil from being forced past. Colloidal graphite lubricates the rod.

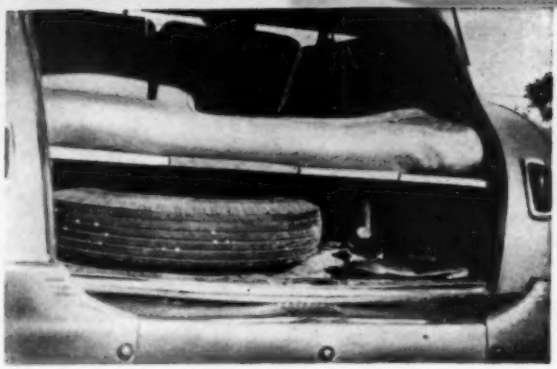
When a bump forces the rod into the cylinder, the oil is compressed and the valve opens, transferring oil to the opposite side of the piston. On the recoil, the valve closes but a restricted return of oil is permitted by a small passage in the piston, thereby damping the action. Two filler plugs in the cylinder facilitate exclusion of air during filling.

Because of their immunity from fatigue, liquid springs are claimed to be longer-lived than those made of steel or rubber. Compared with a conventional metal spring that will do the same job, the liquid spring also saves much weight and space.

A 40-lb. spring is used on each undercarriage of the Halifax bomber. It is 21" long and 4" in diameter.

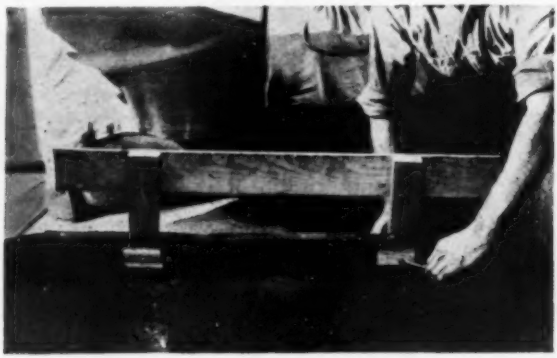


Full-length sleeping comfort on vacation trips is provided by this modification of a two-door sedan. The foot of the bed is in the trunk.



Here's how the bed looks from the trunk end. This one takes a 6' double mattress. There's room for the spare tire and tools under it on the floor.

The other end of the pipe is held between blocks. If the spare-tire brace isn't on the side, put in blocks at both ends and use a wood crosspiece.



For the front support, a T-shaped piece is bolted to the front of the rear-seat frame. A sort of low sawhorse will do if bolting is inconvenient.

Build a Bed in Your Car

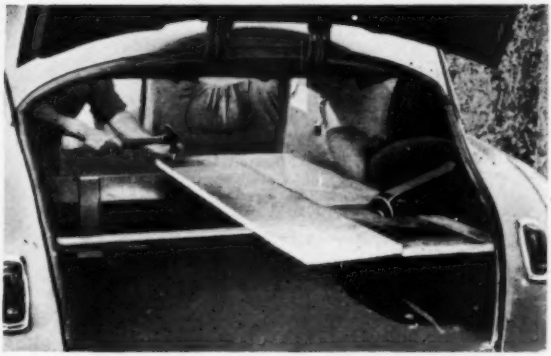
CONVERTING your car so that it will serve as a bed on vacation trips isn't a difficult job, and it will free you of dependence on tourist courts and hotels. Most coaches and sedans as well as many coupes can be modified simply by removing the back seat and adding a mattress platform. Though less flexible than arrangements in which seat backs fold down to form a mattress, the conversion is far simpler and entirely satisfactory.

After removing the rear seat and cushion, take out the cardboard or fiber trunk partition by removing the screws or prying off the locking buttons. If there is a light channel-iron brace between the seat and trunk, saw it out and drill holes so it can be replaced later with strap-iron "splints" and bolts. In cutting, leave stubs long enough to take the replacement bolts.

Many cars have the spare-tire bracket on one side of the trunk. In this case, a length of 1" pipe can be fitted over the bolt in the tire brace and run to a notched wooden block fastened at the opposite side. It serves as a support for the foot of the bed platform. If there is no tire bracket on the side, use wooden stands at both ends of the support, which then may be a length of 1" by 3" stock turned on edge. In any event, level the support by having the blocks or the block and bolt at the same height.

Build a support for the head of two uprights and a 1" by 3" crosspiece bolted to the seat-cushion frame or, if this is impracticable, on small sawhorse legs placed close

After removal of the back seat, supports for the bed platform are put in. One can be a length of 1" pipe over a nut in the spare-tire side brace.



Finally planks are nailed to the front support as a platform for the mattress. When the vacation is over, the bed is taken out and the seat put back.

By H. C. Marhoff

to the back of the front seat. Be sure it is level with the foot support. Nail planks for the platform to the front support; their length will be governed by available car space and the length of the mattress. Notch the outer plank on the tire-bracket side to pass this bracket, which will serve as an anchor. If there is no side tire bracket, anchor the two outer boards with metal straps held by body bolts.

Almost all coaches have room for at least a 6′ mattress. Extra blankets folded under the mattress will make up in part for lack of a bedspring, though an air mattress is preferable. The spare tire and tools can go under the bed platform. Luggage can be carried on the bed when traveling and stacked at night on the front seat.

Replacement Front-Seat Unit Folds Back into Car Bed

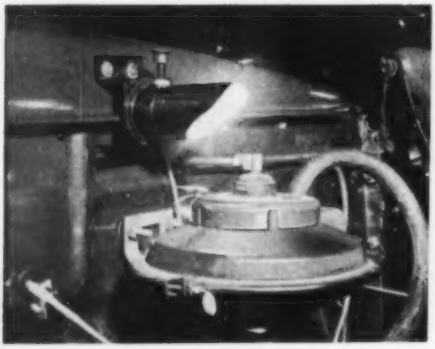
In the commercial field, the problem of putting a bed in a car is solved by a front-seat unit that replaces the original front seat and can be installed in most cars in less than an hour. Its back folds down level with the cushions in the front and rear seats to make a comfortable bed that is long enough for most sleepers even in a short club coupe.

The seat is a product of the California Car Bed Company, of Los Angeles, and is listed to sell for under $100. The car owner keeps his old seat for reinstallation when he trades in the old car.

Bolted to the original frame, this front seat serves for ordinary driving purposes, is adjustable for leg room, and pivots forward.

In a few seconds its back is let down and its seat cushion adjusted level with the back seat to form a comfortable double bed.

AUTO IDEAS

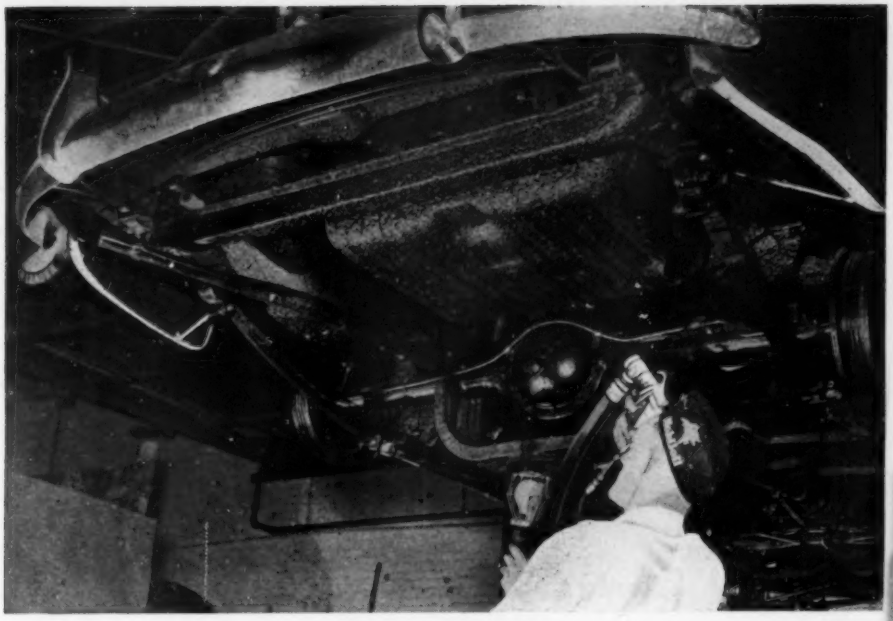


LIGHT UNDER THE HOOD. An engine-compartment light recently placed on the market by the Ford Motor Company lights up automatically when the hood is raised. Quickly installed with self-tapping screws, the light can be connected to the starting-relay switch, voltage regulator, or any hot output wire. A rubber-covered spring-type switch operates the light.

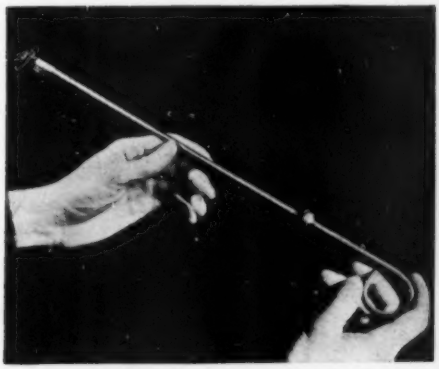
STEEL WIRE HALTS BLOWOUTS. Woven into the top ply just below the tread of the tire shown here is a network of steel wire, intended by the United States Rubber Company to lessen the likelihood of blowouts on heavy trucks. In addition, the wire permits the use of fewer plies and gives a cooler-running carcass. The tire is still in the experimental stage.

SAFETY LATCH ON REAR DOOR. Parents will be interested in this lock that prevents the opening of the rear doors when the front doors of a car are closed. The catches are easily put on any car with a screwdriver and retail for $2 a set. They are made by Jelco Company, of Minneapolis, and distributed nationally.

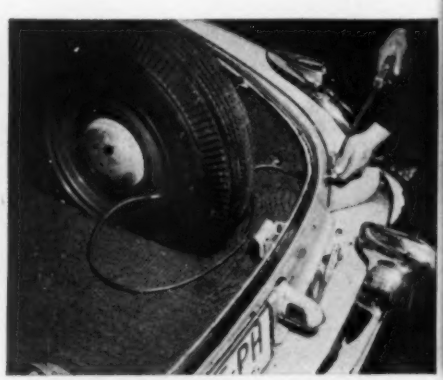
SHADE CUTS SKY GLARE. A sheet-aluminum shade with stainless-steel and chrome-plated brass fittings affords drivers protection against overhead glare. It is made by the Fulton Company, of Milwaukee, in sizes to fit most popular and de luxe models of 1942, 1946, and 1947 cars and many others of older make.



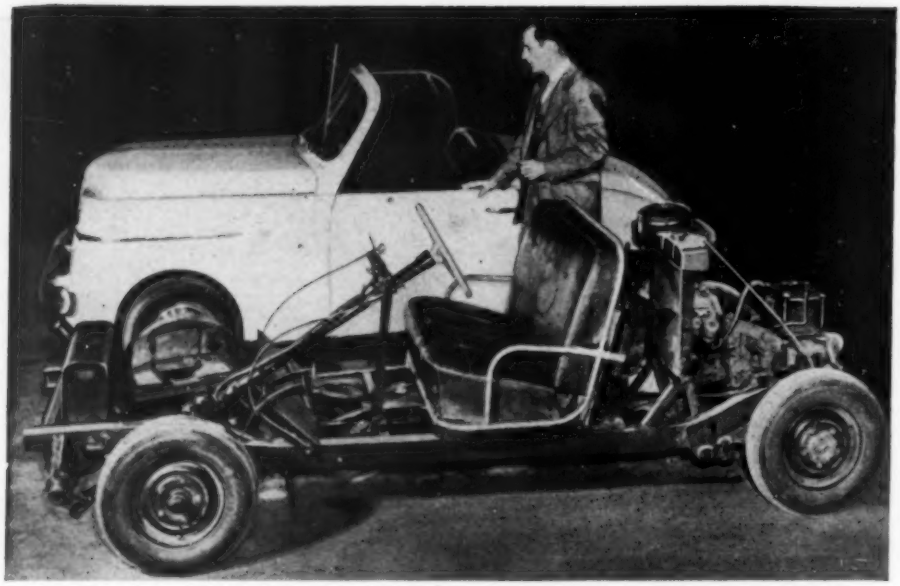
SPRAY PROTECTS CHASSIS. A rubberized material developed by the Minnesota Mining & Manufacturing Company, of Saint Paul, Minn., may be sprayed on the underparts of a car as a protective coating against corrosion, moisture, and flying sand or gravel Sprayed into cracks and crevices, it also prevents many squeaks and rattles. As seen in this photo, the coating is not applied to such parts as the springs, axles, or exhaust pipe. The material is such that only one coating is needed for the lifetime of a car.



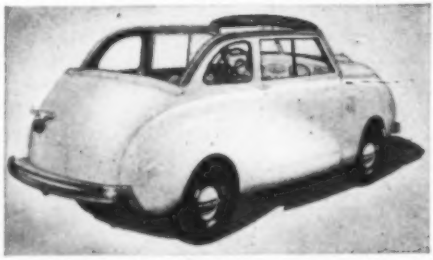
MAGNETIZED DIP STICK CLEANS OIL. This dip stick is permanently magnetized so it will clear oil of any ferrous particles that wear or break off working parts. The stick, which also serves to measure the amount of oil in the engine, is enameled white to show contrast quickly. It is made by the O. B. Briggs Mfg. Co., of Toledo, Ohio.



EASY INFLATION OF THE SPARE. A new device that permits inflation of the spare tire without raising the trunk lid is sold for $1.75 by Curtis Automotive Devices, Inc., of Dayton, Ohio. It consists of tubing, a grommet, and all necessary fittings, including a handsome chrome cap. Installation involves drilling a 5/16″ hole.



Sturdy and compact, the new Bobbi-Kar will come in several body styles, some with the engine in the rear.



For those who like sunshine, Crosley offers this new convertible. The top slips back into the rear.

Said to reach 60 m.p.h. with ease, the rear-engine Playboy seats three, weighs 1,820 lb., and has an automatic transmission. The price is about $950.

Rear Engines Run New Midgets

REAR engines and independent suspension of all four wheels are noteworthy mechanical features of two of a half dozen or more midget cars now being developed in the United States for the 1948 market. Several designers also have projected three-wheel vehicles. Intended to sell within the $500-$1,000 price range, the small cars all are said to give 35 to 50 miles a gallon.

Leading entrants in the small-car field, now dominated by the Crosley, are the Playboy and the Bobbi-Kar. The Playboy is made in Buffalo by the Playboy Motor Car Manufacturing Corp., and the Bobbi-Kar in Birmingham, Ala., by the Bobbi Motor Car Corp., which has reorganized and moved from San Diego, Calif. Both vehicles have four-cylinder, water-cooled engines.

A convertible, the Playboy has an overall length of 156″, height of 54″, and width of 58″, the body and frame being welded as one unit from steel components. Four-wheel hydraulic brakes and independent springing are other features. The Bobbi-Kar has a wheelbase of 92″, an overall length of 168½″, and a seat width of 49″.

MECHANICS AND HANDICRAFT

PSM PHOTO BY ROBERT F. SMITH

- De Luxe Portable Radio
- Escalator for the Home
- Car-Top Catamaran
- Take-Along Photo Enlarger
- Impulse Water Wheel

Sit Down and Ride Up

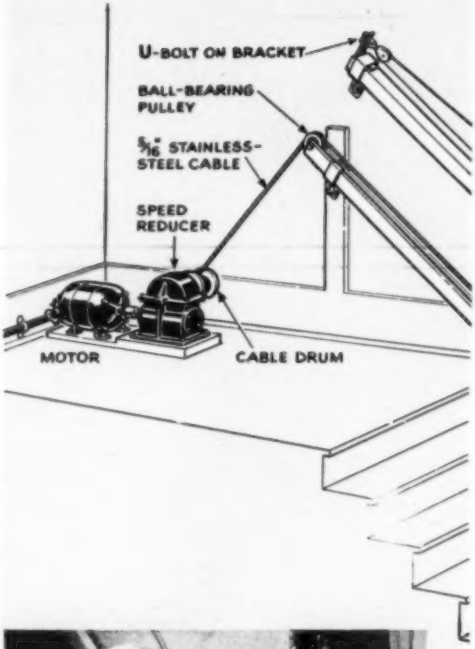
Stair elevator on garage-door rails provides safe lift to second floor for invalids and convalescents.

SEMI-INVALIDS and some elderly people find going up and down stairs a task beyond their endurance. For them some sort of elevator arrangement in the average two-story house is a real boon. The problem isn't too difficult for the resourceful handy man to solve, provided the flight is straight, without turns or landings.

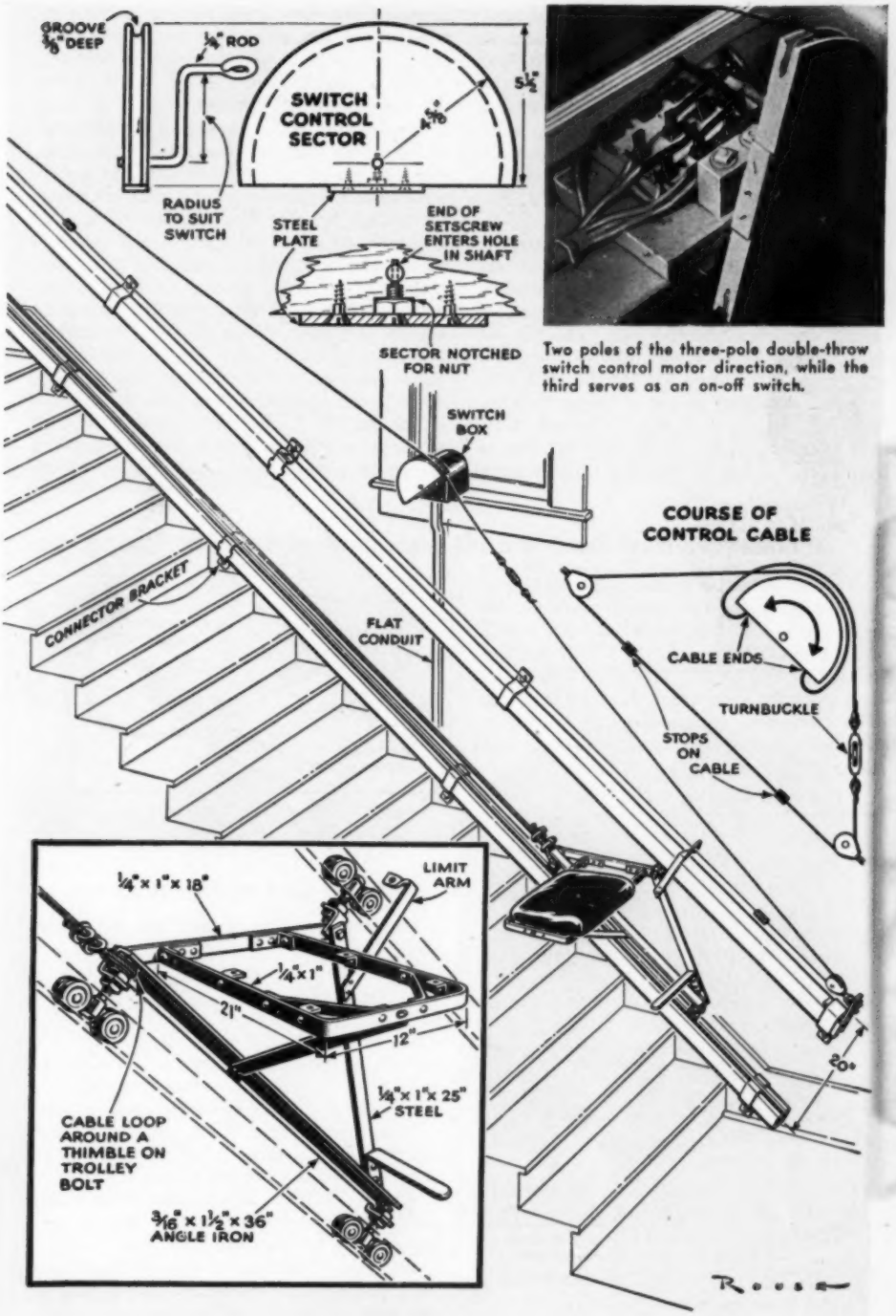
Alfred E. Flostroy, faced with this situation in his home in Bayside, L.I., built a one-passenger stair elevator with a set of overhead garage-door rails as a track, three trolleys, a ½-hp. 1,750-r.p.m. motor, and a 50-to-1 irreversible speed reducer. An ingenious switching arrangement by which the passenger can start the elevator at either the top or bottom was set up with the switch box at a mid-point on a convenient sill. Stops at both ends of the switching cable are activated by a limit arm to halt the elevator in position for alighting.

The motor used necessarily had to be of the kind capable of starting under load, such as repulsion-induction or capacitor-start. An irreversible worm-gear type of speed reducer lets the car move only when the motor is powered, and prevents coasting (it does, of course, run backwards when the motor is reversed). It has a strong ¾" shaft fitted with a 2" drum on which the cable winds. A 5/16" stainless-steel cable anchored to the drum and clamped around a thimble over the bolt of the near trolley has been in use for over a year without showing signs of wear.

Angle iron, angle brackets, and ¼" by 1" steel stock were used in building the carriage that rides on three sets of trolleys between the rails. The upper carriage member is horizontal to hold the seat frame level. This frame was also made of ¼" by 1" steel. It



Merely a pull on the control cable starts the seated passenger up or down. The elevator is halted automatically when it reaches the limit of its run. A carriage to which the seat is bolted travels on three sets of trolleys.



Two poles of the three-pole double-throw switch control motor direction, while the third serves as an on-off switch.

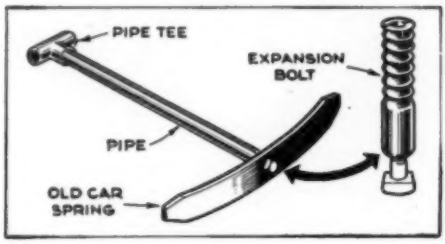
was braced at the corners and fitted with drilled lugs to which an upholstered seat, in this case one from a typewriter chair, was bolted. Unless the stairs are wide and the top and bottom well lighted at all times, it is a good idea to equip the seat frame with hinges so it can be folded against the wall, where it won't be in the way when not in use. The bar for the footrest should likewise be hinged.

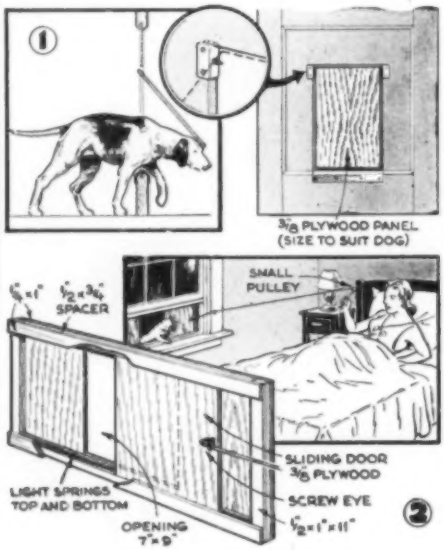
Since it was most convenient to place the bottom rail against the baseboard, a spacer had to be put between it and the wall at the upper end. This might not be necessary in the case of a paneled wall. The bracket holding the bolt of the trolley riding the upper rail was turned toward the wall, so it was not necessary to use a spacer to bring that rail directly over the lower one. Care was taken in drilling the trolley brackets to halve the distance between the vertical planes of the rails so the trolleys would run without binding, and to get the rails exactly the same distance apart at top and bottom.

The switch that starts, stops, and reverses the elevator motor is controlled by a cable run over pulleys hung on U-bolts at the ends of the upper rail. It is mounted on a plate to which is pivoted a grooved wooden sector on a bent rod having an eye that encircles the switch handle. Ends of the cable are anchored at opposite ends of the control sector, and the cable is run over it in the grooves. The cable section between stops is threaded through an eye in the limit arm on the carriage. When this arm strikes a stop, the switch blades are thrown up to break contact. Then a further tug on the cable in the same direction puts the blades in the opposite contact clips and starts the motor in the reverse direction. A turnbuckle assures proper cable tension. END

Anchor for Small Boat Is Built from Leaf of Old Car Spring

FASTENED to the end of a length of pipe by an expansion bolt, a leaf from an old auto spring provides firm anchorage for a light dinghy or other small boat. A standard pipe tee is screwed to the other end of the shank as a stock through which the rope is passed. The car-spring arms will catch quickly on the bottom and are strong enough to hold fast.—RONALD EYRICH.



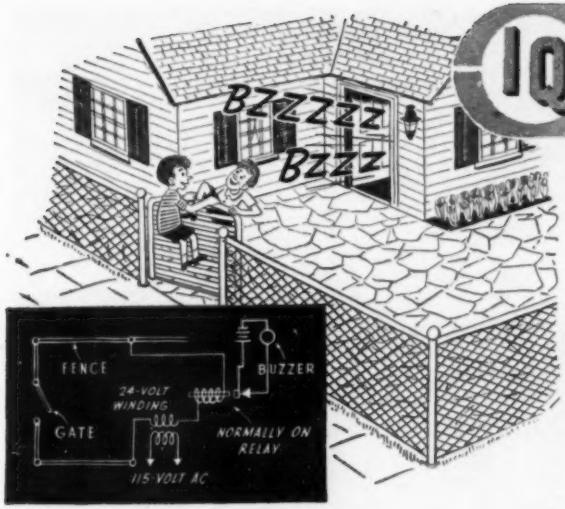


Private Door Lets Your Pet In or Out of the House

GETTING up to open the door every time your dog or cat scratches to get in or out can become tiresome. Figure 1 shows a swinging door that a dog can open without help. It is a rectangle of plywood fitted into a dog-size opening in the lower panel of the kitchen or other house door. The hinge at each of the two upper corners consists of a screw set in a sheet-metal bracket screwed to the door panel. A metal guard, filed smooth on the edges and screwed down tight, frames the bottom of the opening.

In Fig. 2 is a sliding window door for letting a cat in or out at night. It is set in a frame held by the sash like some window ventilators. The door is opened by a cord on a pulley and is closed by coil springs in the slide channels.—HI SIBLEY.

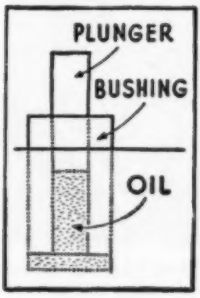
IQ WHAT'S YOUR INGENUITY QUOTIENT?



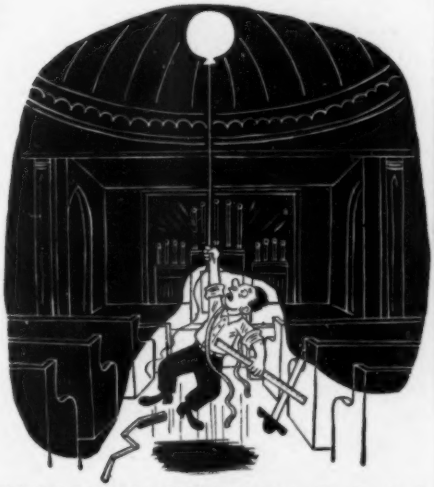
SHUT IT, RICHARD! It's impossible for anyone to enter or leave our back yard—by the gate—unknown to us, for a buzzer near the kitchen door sounds whenever the gate is open. The diagram shows how it's done. We rigged up the system because forgetful persons were always leaving the gate ajar, letting our dog out and unwanted dogs and other trouble in.—Fay O. Wood.

THIS IDEA'S A CRACKERJACK. Ever want to mail a cake with icing? If so, don't bother with sticky wax paper. Just buy a dime can of popcorn, pop it, and stuff it in the box around the cake. Not only will the popcorn be edible, but if it picks up some of the icing so much the better.—Alta Bond.

Have you pulled off a smart one lately? We will pay for acceptable contributions showing ingenious solutions of problems in the home, shop, garage, or camp. It doesn't matter if it's wacky — if it works.

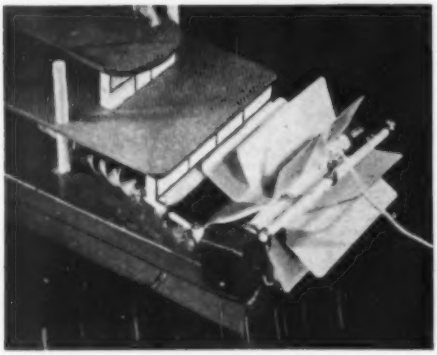


OUT IT COMES! Hydraulic pressure is harnessed in this method of removing a tight blind bushing. Pour heavy oil in, insert a close-fitting round steel bar, and hammer it. The oil will transmit the force to the inner bushing end.—G. R. Shaw.

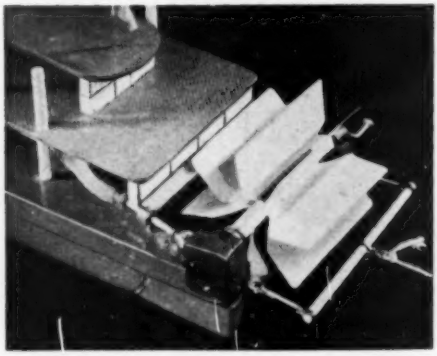


BALLOONS IN THE BELFRY. Confronted with the problem of measuring the interior height of a church dome, we tied a gas-filled balloon to a spool of coarse thread, let the balloon ascend to the top of the dome, cut the thread at the floor, and then measured the thread.—Ronald Eyrich.

This stern-wheeler is a working model that will churn along valiantly on neighborhood streams and ponds



Inserted between paddles, the brake rod keeps the wheel from turning until the boat is in the water.



Then the paddle wheel is released by a pull on the cord, which is also useful in retrieving the boat.

Rubber Bands Drive Model of Stern-Wheeler

RIVER boats have always been picturesque. This one, a 14" stern-wheeler, is driven by rubber strands and a pair of small bevel gears. It will run at fair speed even against a light current. A paddle-wheel brake locks the wheel until the boat is in the water. At the end of its run it is retrieved by the brake cord.

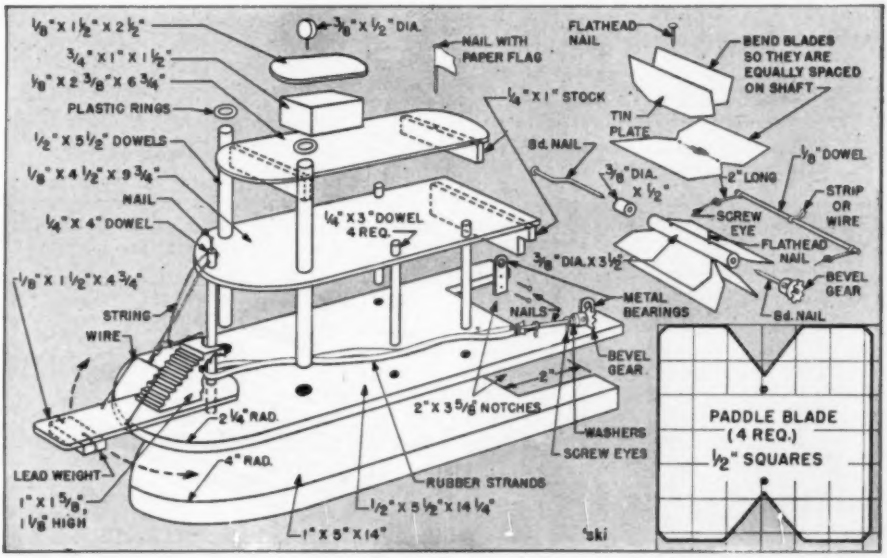
Make the hull from two solid blocks, notched to receive the wheel and bored to take seven dowels, the two largest of which are painted black to resemble smokestacks. A gangplank pivots loosely on the forward dowel. It may be arranged to lift by means of a cord. A lead weight gives it a steering effect; the boat turns to the side to which the gangplank is swung. Steps can be cut from the solid or built up by joining thin layers.

The upper decks may be cigar-box wood, plywood, pressed board, or even heavy cardboard. A block on top forms the pilot house and a short length of dowel the headlight. Two plastic rings were cemented to the top of the smokestacks (cardboard bands would do as well) and wisps of cotton can be glued on to simulate smoke.

Make up the eight paddles for the wheel in pairs. Bend two pairs at a rather sharp angle and the other two not so sharply so they will be spaced evenly when attached to the dowel shaft with two flathead nails. Drive one nail through from each side and clinch the ends to complete the fastening.

Drive the bevel gears on nails big enough to be a tight fit. Insert one nail through screw eyes and bind on rubber strands after looping them around the forward dowel in the hull. The other mounting nail is driven tightly into an undersized hole in the paddle shaft so the gear will turn the paddle wheel. At the opposite end another nail is driven in and bent for a winding handle.

In selecting the gears, choose a pair not over ¾" in diameter that will mesh at about a 30-deg. angle. The teeth should be rather coarse—about 10 to the gear will do—so alignment won't be critical. It is a good idea to cover the gears with a box bent up of tin-can stock.—DOUGLAS GRAY.

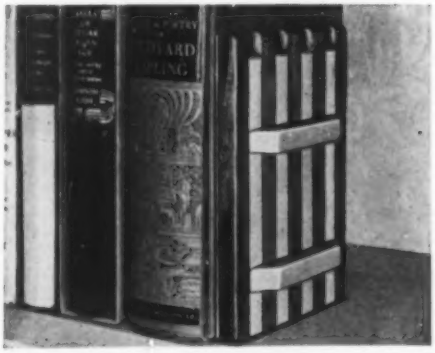


Here are the construction details. Parts are assembled with waterproof plastic glue and nails. None of the dimensions is critical, so don't hesitate to change them to suit pieces available in your scrap bin.

Strip Projects Utilize Scrap

Pieces of varying length make "drawbridge" book ends. Chains and escutcheon pins decorate them.

Screws through the underside hold the letter-rack posts. Make the rear rail higher than the front.

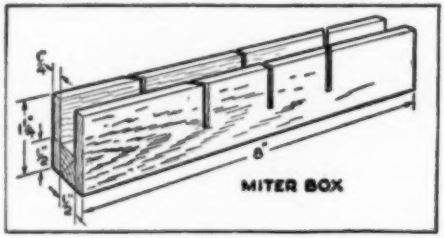


Sheet metal fastened with countersunk screws and covered with felt acts as a base for this book end.

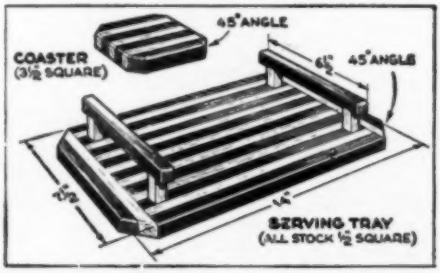
GIVEN a few odd scraps of cabinet wood and a circular saw, you can turn out, in a few hours' spare time, a dozen small craft projects made of strips ½" square. In the photos are two book-end designs and a letter rack; in the drawings are suggestions for a small tray and coasters. The field is wide.

Rip the stock into ½" strips, cut to required lengths, sand smooth, and glue up the flat members. Then join the parts with glue, driving in screws for added strength where they will not show, or using small finishing nails and puttying over after setting the heads. A miter box that will fit ½" strips will be helpful for cutting both square and mitered ends. One shown in the drawing was made up from one of the strips and two pieces of ¼" by 1¼" stock.

Interesting contrast is possible with strips of different kinds of wood, such as maple with walnut or mahogany, or birch with mahogany. Ends and outer edges are best beveled, and a bevel is sometimes effective on the edges of joining faces, as in one of the book-end sets. An oil finish will give good results on most of the woods likely to be available.—R. J. DE CRISTOFORO.



Mitered and square corners are best cut with the aid of a miter box that will fit the strips used.

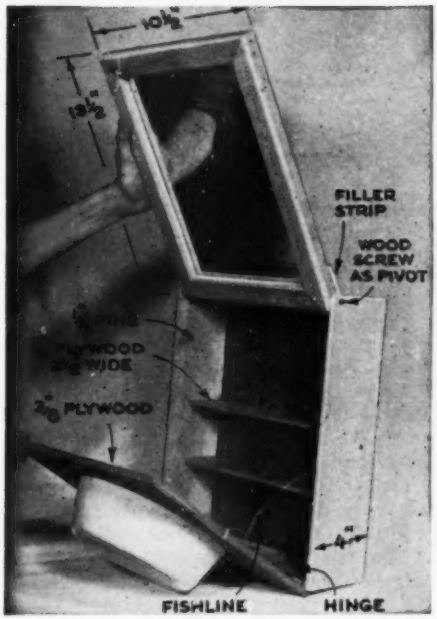


Projects in two tones require an uneven number of strips so opposite edges will come out matching.

Summer-Cottage Shaving Kit Has Mirror and Basin

MANY camp and beach cottages have no place for the morning shave except in the kitchen, and this frequently interferes with breakfast preparations. This box for shaving equipment is built around a mirror and a small basin for the shaving water. It can be hung on any window sash where plenty of light will strike the face.

Dimensions, of course, will depend upon the size of the mirror and the basin used. The mirror is pivoted on a dowel to swing up against the window or wall and down under the basin panel. This drop front is short enough to allow the shaver to get close to the mirror. It is held by regulation hinges and fishline.—WILLARD ALLPHIN.

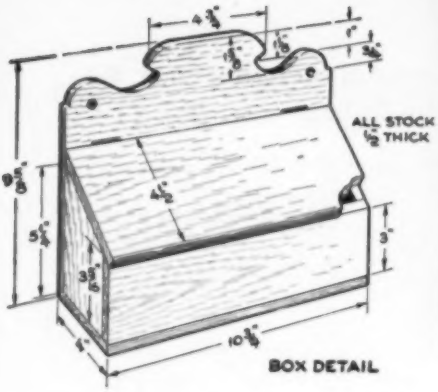


Shelves in the kit will hold the razor, shaving soap, lotion, powder, and even a small hand towel.

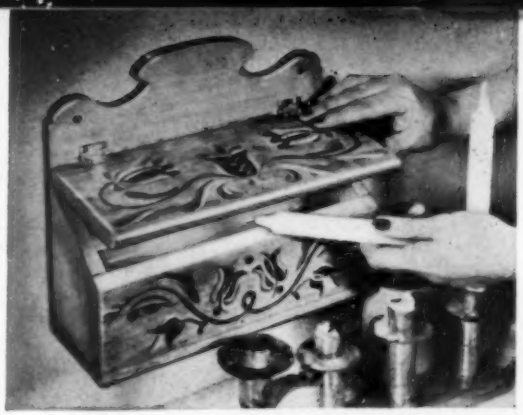
Folded, the box can be put away with the shaving equipment inside and the basin still in its place.

Marine Canoe Glue Binds Cloth Patch to Canvas-Covered Boat

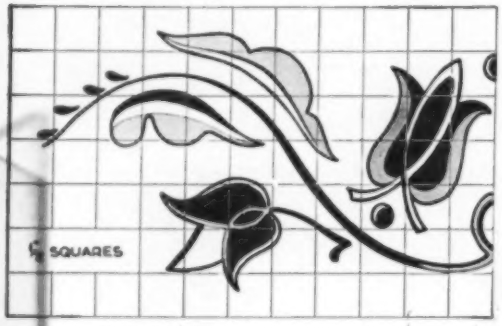
RIPS and worn places in the coverings of canvas boats can be repaired with marine canoe glue heated and daubed over the spot, where it will harden quickly. A patch of unbleached muslin or any light fabric, not heavy canvas, is laid over the glue and a hot iron applied. This melts and sweats the glue through, binding the patch and old cover. Such a patch can be smoothed and painted so it will be hardly noticeable.

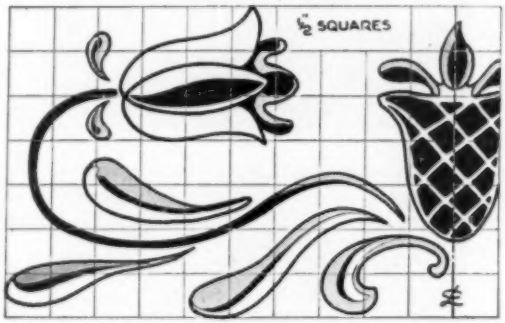


BOX DETAIL



Gay decorations are painted on a pine background.





Box for Candles Is Ornamented with Painted Peasant Designs

STORAGE of candles where they will be accessible but protected is a problem in a cabin or summer cottage. This pine box with a hinged lid keeps them out of reach of small children. It is shown in color on page 116.

Construction is very simple, with all joints butted and nailed. Make the back in one piece and lay out the scroll-sawed curve freehand or make a cardboard template for one side and turn it over to get the other symmetrical. The back edge of the lid is beveled at a 60-deg. angle.

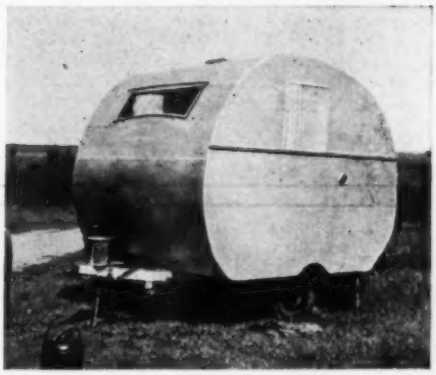
Apply three thin coats of orange shellac to the entire box. This will accent the natural yellow of the pine and, when sanded smooth, make a good foundation that will help keep the painted design from running.

Transfer the design with pencil or carbon paper. Use oil colors from tubes, thinning a very little with turpentine and adding a drop or two of drier. If the paint is brushed on fairly dry and with restraint, one color may be put over another and the decorating completed at one sitting. After the oil colors are fully dried, the box may be antiqued with a thin glaze of burnt umber wiped while tacky from the center toward the edges.—DORIS ALLER.

Rubber Ring Keeps Bits on Drill

STRETCHED over a length of corrugated cardboard around the body of an electric hand drill, a section of auto or motorcycle inner tube holds drills securely and ready at hand. Fold the piece of tubing back on itself and put the cardboard between. Turn back the rubber flap to reach the drills, as shown.—J. A. RICHARDS.

They Built PSM Projects



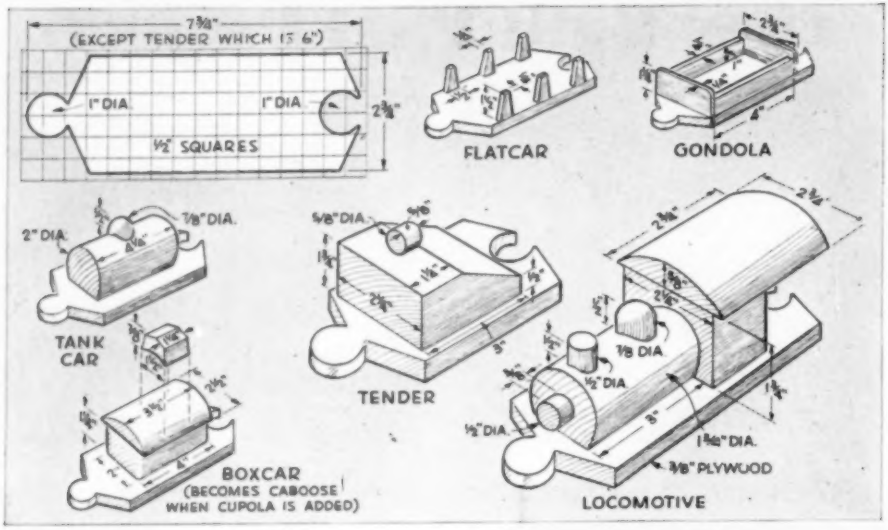
TWO VERSIONS OF THE TRAILER. Here are two ways readers adapted the trailer published in PSM (Mar. and Apr. '46) to their own needs. John Rzeszutek, of Minneapolis, built the trailer at left, using ⅛″ pressed composition wood for the outside, ⅛″ mahogany army-glider plywood inside, and ½″ insulation board between with ¾″ air space on both sides. To increase the sleeping space to accommodate four, two twin-bed springs were installed double-bunk fashion across the rear. With three other men he lived a week in the trailer near the Canadian border during deer season.

Howard H. Beach, of Zion, Ill., also adapted the sleeping arrangements in the trailer at right to accommodate four by hinging drop leaves on the two beds. He reduced the cost at least by half by using hard composition board instead of plywood.

AUTOMATIC RECORD CHANGER. The oscillator in this changer, from plans in the March '46 PSM, is built in under the player mounting board. Richard N. Beemer, of Mason City, Iowa, uses a double-pole double-throw switch to operate the player either through the oscillator or by direct connection through an amplifier. Volume is controlled by a 1-megohm rheostat when the player is hooked up directly.

A mounting board of ¾″ plywood is used for the changer. The cabinet is ⅛″ pressed composition wood 11″ high, 15″ wide, and 17″ long. It is finished with three coats of semigloss ivory and trimmed in brown.

PLYWOOD BOAT. Eight members of George McGinnis's woodworking class at the Goshen, N. Y., Central School joined in constructing this boat from PSM plans published in June and July '42. They spent an hour a day on it five days a week for three months. Waterproof plywood was used for the hull. The boat is used with an outboard motor, but also does nicely with oars.



Toy Train Keeps Tots Busy

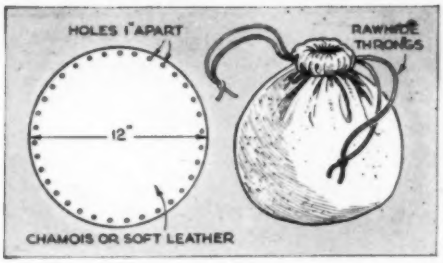
Those first railroad cars for the future engineer can be built of a few scraps of ¾" plywood, some pine blocks, dowel ends, and orange-crate wood. Knob-and-socket couplings provide an easy method of making up trains. Two or three evenings in the basement should be sufficient for turning out a locomotive and a half-dozen cars.

Make a template of stiff paper for the bases and scribe around it on the plywood for as many pieces as you plan to make. The same template is used for all bases except that for the tender, which is only 6" long. File and sand the knobs and sockets so any base can be coupled to any other and allow a turning angle between cars of at least 25 deg. to either side.

The locomotive cab, tender, and boxcar bodies are held on by glue and finishing nails. Top the cab and boxcars with ¾" pieces planed slightly round on the upper side, and add a cupola to convert one boxcar into a caboose. The locomotive boiler and tank-car bodies are rounded blocks or pieces of closet pole. Domes, smokestack, and headlight can be spools or dowel ends. The gondola sides and flatcar stakes may be of orange-crate stock. Enamel in various colors.—Budd Salsig.

Wrench Serves as Nutcracker

If your basement shop boasts one of those new lock-grip wrenches, try using the tool as a nutcracker the next time you want to remove the nut meats whole. Adjust the wrench jaws just tight enough to break the shells; then no matter how much pressure is put on the handles the jaws won't come so close they will break the meats. Several adjustments of the jaws may be necessary if the nuts are not all the same size.

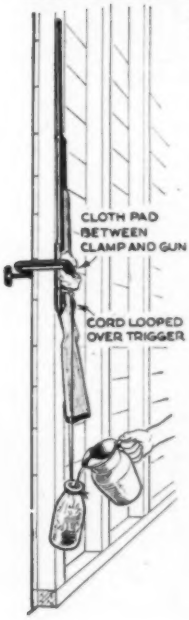


Oiled Bag Keeps Fishing Reel from Rusting in Tackle Box

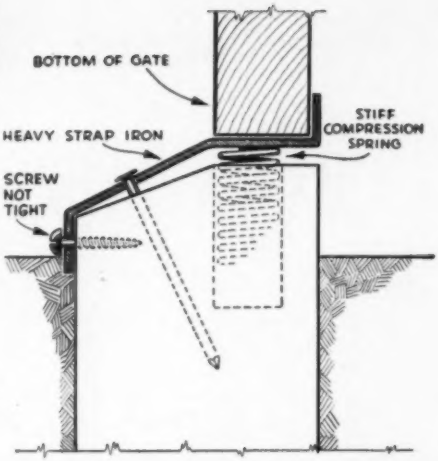
SOFT leather or chamois cut in a circle will make a good protective bag for a fishing reel. Stretch out the material on a bench or a wide board, tack it down tightly, and trace a 12" circle on it from a cardboard pattern. After cutting out the piece with shears, punch holes about 1" apart near the edge. Use a pair of rawhide shoelaces as drawstrings to pull the wide mouth of the bag up tight around the reel.

Chamois is preferable for the bag since it can be kept well oiled at all times and thus reduce the chance that the reel may rust in the tackle box.—R. A. JENKINS.

Bottle and Cord Test Trigger

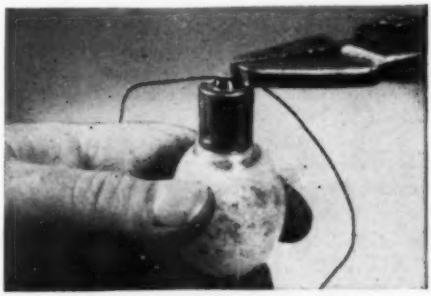


CLAMPED to a stud at the garage door, the trigger pull of a shotgun, rifle, revolver, or pistol can be tested accurately. Tie a 1-qt. or ½-gal. bottle to the trigger by a long cord so it is suspended about 6" above the floor. Then slowly fill the bottle with water from a pitcher, stopping as soon as the weight pulls the trigger and the firing pin clicks. The weight of the bottle and water equals the trigger pull. This varies, according to gun and taste, from ½ lb. or less up to around 3 lb. Be sure the gun is unloaded.



Friction Catch Latches Gate

A SHORT piece of heavy strap iron and a stiff compression spring form the working parts of a reliable catch for a small garden gate. In the end of a 4" by 4" block, bore a hole that is slightly larger than the spring but about 1" shorter than the spring length, and chamfer one edge away from the hole. Soak the block in creosote and set it in the ground near the outer edge of the gate. Bend the strap to shape and fasten it with a roundhead screw and a 16d. nail that are left a little loose.—W. P. SHEPHERD.



Flash Bulb Is Fishing Bobber

BURNED-OUT miniature flash bulbs can be made into good fishing bobbers by splitting the solder on the end contact with a knife, inserting the line, and closing the solder on it with pliers. The bulbs will not become waterlogged and can be used for a long time. Their white appearance makes them easy to see on the surface of the water.

Glass-Topped Desk Conceals Typewriter

By Bernard I. Bell

MODERN in its conception, materials, and convenience, this glass-topped desk is of plywood construction. It has a shelf for magazines and reference books, ample drawer space, and a special drawer serving as both support and cover for a portable typewriter.

To cut down on the cost of the material, which is quite costly in hardwood-faced varieties, ¾″ plywood with a white-pine face was used and stained, varnished, and waxed to match the other furniture in the room. However, it is sometimes possible to obtain plywood beautifully veneered with such cabinet woods as primavera, mahogany, bird's-eye maple, and birch. Only one piece, the right-hand end, need be faced on both sides, so single-faced stock can be used everywhere else if you wish to work with one of these veneered woods.

The drawer supports may be ordinary ¾″ fir plywood. This same kind of plywood, but in ⅜″ thickness, may also be used for the sides, bottom, and back of the drawers, although ¾″ oak plywood will prove sturdier.

All exposed edges and ends are veneered with thin strips ripped from solid stock of the same wood as the plywood finish face. This will conceal the end grain and produce a neater job. Strips 1/16″ thick will do in most cases, but those covering the ends of the glass-top retainers, the strip at the left and dowel at the right, should be ⅛″. Since the bottom stretcher is subject to scuffing, ¼″ facing strips should be applied to its edges.

Splined miter joints are used in the drawer compartment at the two joints between sides and back and the right-hand and rear joints of the top to eliminate as many exposed plywood edges as possible. Note that the joint at the right front corner must be a blind miter, the bevel on the top stopping short of the front edge, since the side is stepped back by the thickness of the drawer fronts.

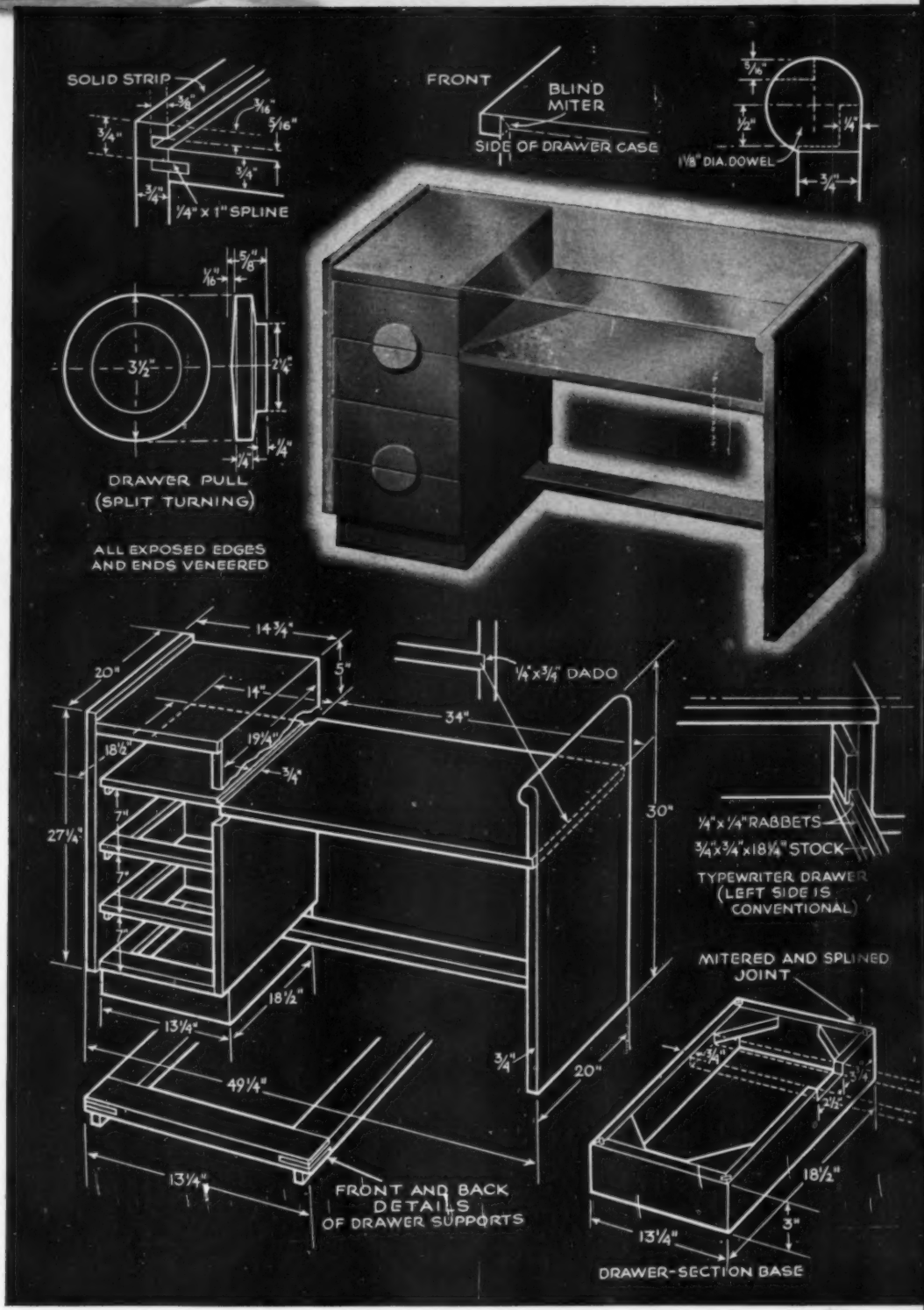
A solid strip is grooved and glued on as a retainer for the glass at the drawer-compartment end, while a rabbeted hardwood dowel or turning serves as a retainer at the opposite end. The top is ¼″ by 19½″ by 48¼″ plate glass. Ample clearance is provided in the groove and rabbet to take it.

Cut all parts carefully and accurately to assure true joints. Glue up the drawer supports as frames, and attach them with glue and screws to the base and to the sides and back of the drawer compartment. The shelf is cut as a single piece extending the entire length of the desk, being reduced in width to go between the drawer fronts and the mitered back as it enters the drawer section. Make the right side of this section in two pieces, the one above resting in a dado in the shelf and the other doweled to it from below. The shelf should be bored through at the dado for the dowels, which should be glued into both sections of the side. Set the shelf into dadoes in both ends, and add hidden cleats for support. Dowel it to the back of the drawer section.

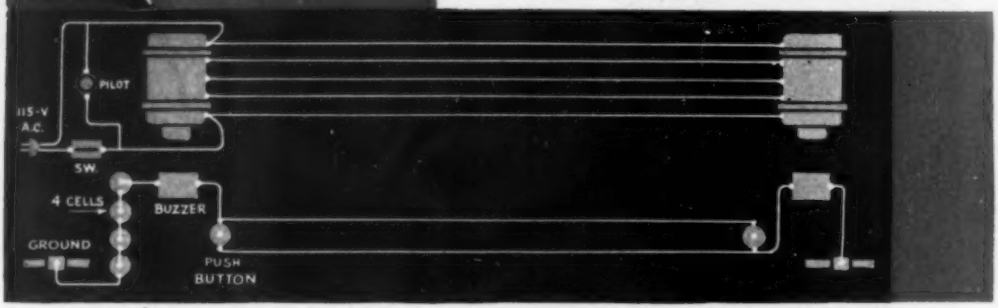
The drawer faces are cut from a single plywood panel so the grain will be matched when they are closed. All drawers are standard construction except the top, which has a rabbeted hardwood runner in place of a right side to make the typewriter keyboard accessible. It slides under a rabbeted hardwood support that braces it when open.

Be sure to measure the height of your typewriter before laying out and cutting any of the parts. If the 5″ depth of this drawer is not sufficient, increase this dimension and make allowance in the other drawers and in the height of the magazine shelf.

The drawer pulls are made as split turnings with paper glued in the joint. When separated, they should be aligned and glued and screwed to the drawer fronts.


SOLID STRIP
3/8"
3/16"
5/16"
3/4"
5/4"
3/4"
1/4" x 1" SPLINE
FRONT
BLIND MITER
SIDE OF DRAWER CASE
5/8"
1/2"
1/4"
1 1/8" DIA. DOWEL
3/4"
5/8"
1/16"
3 1/2"
2 1/4"
1/4"
1/4"
DRAWER PULL (SPLIT TURNING)
ALL EXPOSED EDGES AND ENDS VENEERED
14 3/4"
20"
5"
14"
34"
1/4" x 3/4" DADO
18 1/2"
19 1/4"
3/4"
7"
7"
7"
27 1/4"
30"
1/4" x 1/4" RABBETS
3/4" x 3/4" x 18 1/4" STOCK
TYPEWRITER DRAWER (LEFT SIDE IS CONVENTIONAL)
MITERED AND SPLINED JOINT
18 1/2"
13 1/4"
3/4"
20"
49 1/4"
13 1/4"
FRONT AND BACK DETAILS OF DRAWER SUPPORTS
3/4"
3/4"
2 1/2"
18 1/2"
3"
13 1/4"
DRAWER-SECTION BASE

Words spelled by the pointer on one of the selsyn dials will be transmitted to the other since the shafts of the pair follow each other accurately.



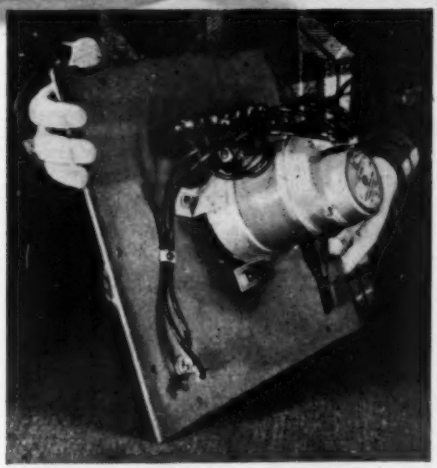
Five wires of a type suitable for carrying house current connect the selsyns. Join the leads to the proper numbered terminals. A separate buzzer circuit for a calling signal is wired with dry cells and a ground return.

Selsyn-Powered Intercom Spells Out Messages

SOME of those mysterious little gadgets that made certain war equipment seem almost like magic are finding their way to the sales counters as surplus goods. One of them is the selsyn, that onetime highly secret device used in antiaircraft weapons, bomb sights, and radar. Selsyns in small sizes can be picked up in dozens of stores now for between $3 and $5, and many of them will operate on ordinary 115-volt A.C.

These selsyns are really directional motors. If two or more are hooked up properly and the shaft of one is revolved, the shafts of the others in the circuit will revolve in exactly the same way, through even the identical arc or fraction of a revolution.

This makes selsyns ideal for operating an intercom system between the house and



Mount each selsyn on the back of its dial panel by means of metal clips bolted to its collar. Run the shaft through to take the letter pointer.

Here are the selsyns, shown front and back. One will be needed for each of the stations wired in.

By Jack Mellinger

basement workshop or garage and even between neighboring houses. For each station in the circuit set up a box having a dial face containing the letters of the alphabet and a line or other indicating mark for a space. Mount a selsyn in each box with the shaft through a hole in the center of the dial. One way to secure it is with metal clips or brackets bolted to the back of the box face and to the collar of the selsyn. Then file a pointer from ⅛" sheet brass or plastic and attach it to the shaft, either between two nuts on the threads or, if the shaft is not threaded, by means of a collar and setscrew.

Take pains with the wiring for, though it is simple, the leads must be connected properly or the circuit will not work. A good method is to attach the leads from each selsyn to a small terminal board and number them in order from 1 to 5, counting as 1 the same first lead from each selsyn. Then connect all 1's, all 2's, and so on. Use rubber-covered hookup wire inside the box and any good wire approved for house current between the stations.

Connect one of the stations to the house current across the outside terminals, through a toggle switch and in parallel with a pilot light that will show when current is on. As a convenience in signaling the other stations, wire in a separate buzzer circuit powered by dry cells. If a water pipe or radiator is used as the ground return, this will require but two more wires between stations. Unlike the selsyn circuit, they can be bell wire.

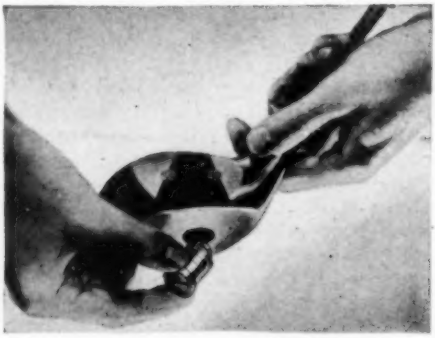
Messages are transmitted by moving the pointer from letter to letter in alternate directions. Buzz once at the start of a message and twice at the end. Use the space between A and Z to separate the words.

Hobby Shopping

D. C. MOTOR WEIGHS 2 OZ. Here is a tiny power plant that will run at 2,000 to 3,000 r.p.m. on one dry cell for operating models, toys, tiny fans, and the like. It is encased in a plastic housing 1" by 1¾" by 1 15/32". Miniature Electric Motors, Inc., of New York, is the maker.

MODEL SAILING YACHT. This 28" long yacht with a 5" beam is designed after Atlantic Class racing sloops. It carries 390 sq. in. of balloon-cloth sail rigged on a 36" mast and 18" boom. The hull is molded from plastic in one piece and weighted with a zinc keel. A special steering device operates the tiller in conjunction with the mainsail, easing the boat into the wind on strong puffs and keeping it under control. Noma Electric Corporation, of New York, is the distributor. The boat is made to sell for about $30. Total weight is 3 lb.

SYNCHRONIZED PUFFING. Smoke from the Lionel locomotives is now synchronized with the action of the driving rods and comes out in puffs. An electric bulb in the smokestack melts a smoke-making chemical placed on it and also illuminates the outpouring smoke so it's sure to be seen.



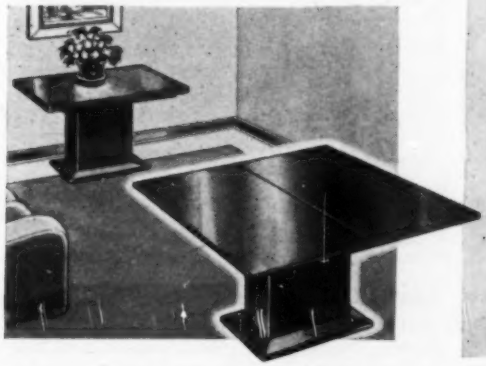
ADJUSTABLE-WEIGHT GOLF CLUBS. A small threaded plug in the sole of each of four matching alumnium-head "woods" provides a means of adding or taking out weights. The plug can be unscrewed with a coin. Reynolds Metal Company, of Louisville, Ky., developed the head.

Folding Table Seats Eight

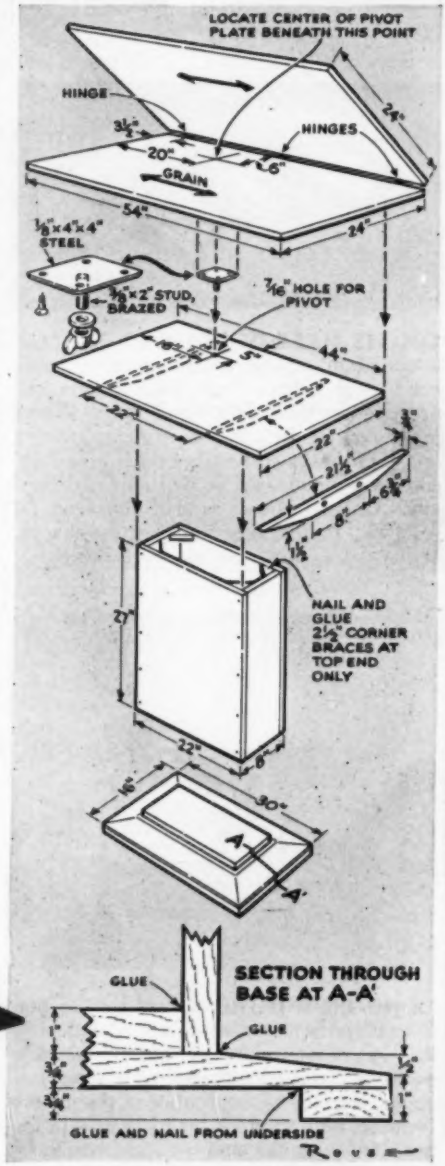
ACCOMMODATING six to eight persons for dinner, this table nevertheless folds so that it can be placed against a wall, where it projects no more than 2′. Its leaf may be folded over completely or supported vertically against the wall in the style of a console table in a living room or an entrance hall. To convert it for use as a dining table, the leaves are swung around at right angles and opened.

Solid stock is used for the base, and ⅝″ or ¾″ plywood for the column, top, and table leaves. If suitable plywood isn't available, satisfactory panels can be glued up from boards, provided dowel or spline reinforcement is employed and enough clamping equipment is at hand. Located as shown in the drawing, the hole and pivot will come just outside the column. A steel plate with a stud brazed on is recessed into the lower leaf. A similar plate without the bolt may be let into the column top. Round the outer edge of both plates. Use three so-called invisible cabinet hinges on the leaves, mortising them into the edges. Dome casters are used under the corners of the base for feet.

The base, column, and outer part of the folding leaf take any finish, but use only a nonsticking finish on touching leaf surfaces and on the upper surface of the column top. Lacquer, enamel, and wax stains are practical for these parts.—EDWARD E. THORP.

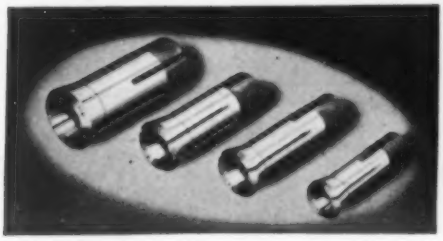


Two uses for the folding dining table. At left, the table folded and placed against a wall will project but 2′ and take little living-room space. Its leaves extended and swung around on the base, the table is large enough for eight to dine.



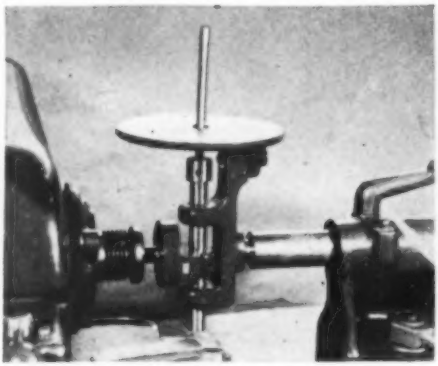
Construction is in four pieces, with the lower three—base, column, and column top—glued and screwed together as a rigid unit. The folding leaves forming the table top are held in place loosely with a pivot bolt and wing nut.

NEW TOOLS

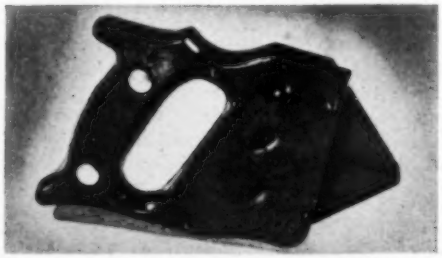


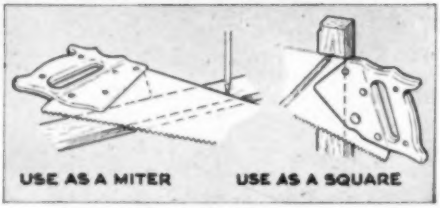
COLLETS MADE OF BRASS. Although not intended to replace more expensive hardened steel collets, new brass collets announced by the South Bend Lathe Works are manufactured to the same tolerances and their lower cost makes them especially suitable for odd sizes needed only occasionally. One advantage is that they can be machined to hold tapers or irregular shapes. When worn, they also can be rebored.

MILLER FOR SMALL SHOPS. Although small, a knee-type milling machine made by the Burke Machine Tool Co., of Conneaut, Ohio, has a big capacity—a longitudinal feed of 6", transverse of 1½", and vertical of 4". Intended for bench or table operation in the small shop, the basic unit above weighs 75 lb., stands 14½" high, and sells for around $140. Table movement is accurate to .001" in all directions. Accessories are available.



FILING ON A LATHE. An attachment produced by the Carey-Anslinger Manufacturing Co., of Kankakee, Ill., quickly adapts a wood or metal lathe for use as a filing machine. Slip the tapered arbor of the attachment into the tailstock, fit its shaft into the headstock spindle, and you are ready for work. Rotation of the lathe spindle gives vertical movement to the file through a Scotch yoke action. The attachment takes standard ¼" shank files, and the table is adjustable for angle jobs.



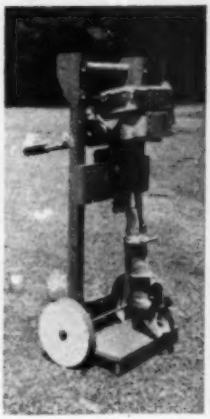


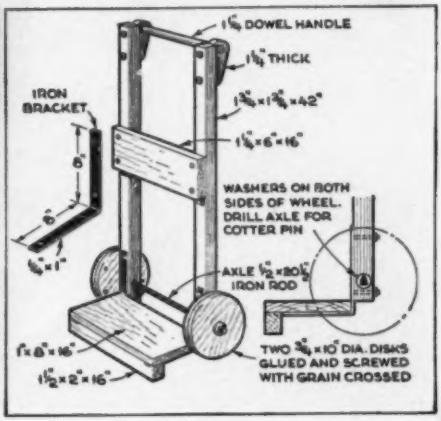
SAW DOES TRIPLE JOB. A plastic handle manufactured by F. A. Collman, of Renton, Wash., converts any straight-back saw into a three-in-one tool. As seen above, the saw then can be used as a 45-deg. miter gauge and a square as well. Selling for $2.25, the handle may be quickly installed in place of an ordinary one.

Wheeled Carrier Saves Back Strain in Toting Heavy Outboards

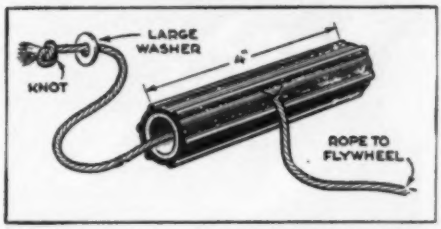
For the boat owner who must lug an outboard motor some distance from his car or camp to the shore, a two-wheeled carrier fills a real need. It will also hold the motor upright in storage.

Dimensions shown are for motors of 3 to 5 hp.; if yours is a larger motor, increase the size and "beef up" the construction. Rubber-tired cart wheels are fine if you can get them.





Rubber Handle on Rope Starts Outboard Motor with Safety



Pull the rope knot against the hole in the side of the hose. The washer keeps it from going through.

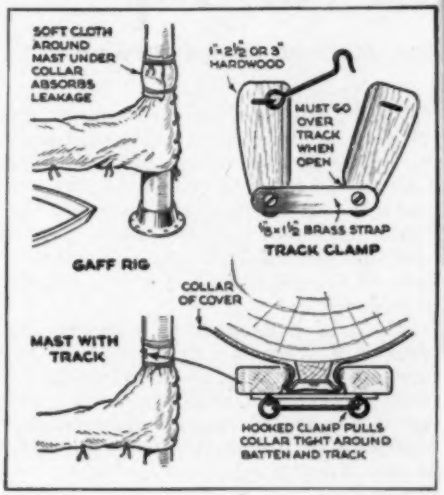
A NONSLIPPING handle for the starter rope of an outboard motor can be made from a 4" length of rubber garden hose. If the rope should get caught in the flywheel, the rubber handle won't damage the motor or injure your knuckles as might be the case with a regulation wooden handle.

Punch or cut a hole midway in the hose, thread the starter rope through, slip a large washer on the end, and knot the rope so it will hold.

Absorbent Pad Helps Keep Rain from Entering Sail Cover

WRAPPED around the mast under the collar of a sail cover, a pad of soft, absorbent cloth such as unbleached muslin or an old Turkish towel will keep rain water running down the mast from getting under the sail cover. Put three or four turns of the cloth around the mast, arranging them partly over the laced main section of the sail cover, and then lash the cover collar over the pad in the usual manner. Water and dirt that pass the upper lashing will be held back by the absorbent cloth.

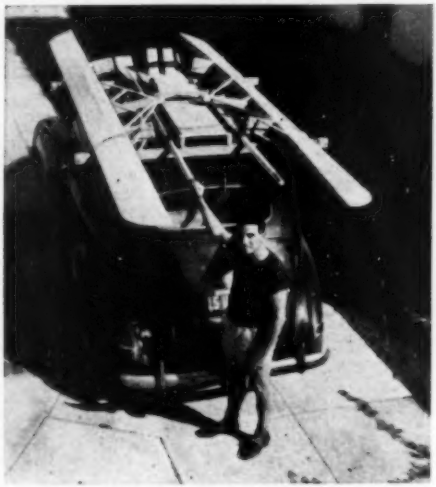
If the mast has a track, use a clamp over the collar to hold it and the absorbent cloth to the track and batten. The clamp can be made from two blocks of hardwood hinged with brass strap and fastened with a heavy hook and eye. Shape the blocks to pass the track flange and hold snugly against the batten.—J. A. EMMETT.



You ride high and fast on this portable, knockdown catamaran. A sliding seat gets leg power into the stroke.

Catamaran Can Be Carried on Car Top

By Robert Lloyd Brown

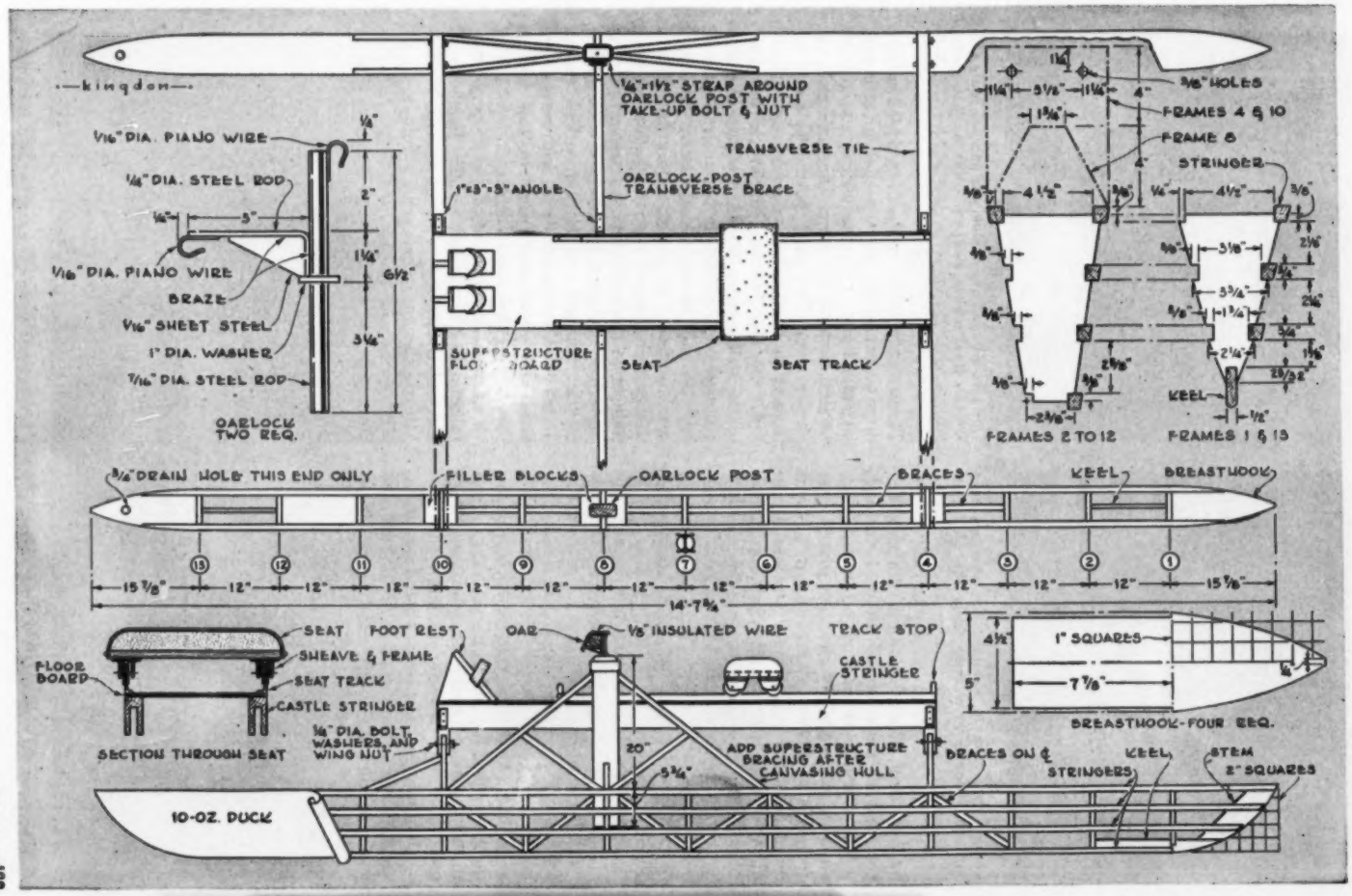


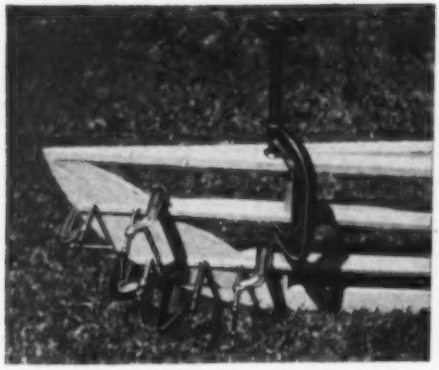
With the hulls unbolted, the superstructure goes on the car top first. Oars and hulls follow, and all are lashed. The seat is put inside the car.

THOSE who take their boating alone can get a lot of fun out of a catamaran-scull. With its single pair of oars, the twin-hulled craft can be rowed at better than 10 knots, and if the exertion is tiring, or you just like lolling in the sun and acquiring a tan, the seat may be rolled forward to serve as a pillow. Danger of capsizing is practically nonexistent.

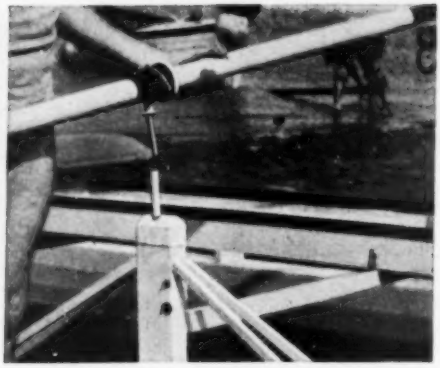
The boat is designed so it can be dismantled and carried on a car top, and the canvas-covered hulls are short enough to store by swinging from the beams of a garage. Reassembly requires insertion and tightening of 12 bolts and wing nuts. The craft is shown in color on page 116.

Fir can be used throughout, but spruce is excellent for the 26 frames and oak for the stringers, braces, filler blocks, stems, and keels. All stock is ¾″ thick except the 1″ by 1½″ oarlock-post transverse brace, the 2″ by 4″ oarlock posts and castle stringers, and the stems and keels, which are ½″ stock chamfered to ¼″ on the outboard edge and rounded. A pair of 2″ by 4″ transverse ties space the two hulls at an over-all width of 74″. The superstructure floor board is a 14″


kingdon
1/16" DIA. PIANO WIRE
1/4" DIA. STEEL ROD
1/16" DIA. PIANO WIRE
BRAZE
1/16" SHEET STEEL
1" DIA. WASHER
7/16" DIA. STEEL ROD
OARLOCK TWO REQ.
1/4"×1 1/2" STRAP AROUND OARLOCK POST WITH TAKE-UP BOLT & NUT
TRANSVERSE TIE
1"×3"×3" ANGLE
OARLOCK-POST TRANSVERSE BRACE
SUPERSTRUCTURE FLOOR BOARD
SEAT
SEAT TRACK
3/8" HOLES
FRAMES 4 & 10
FRAME 8
STRINGER
KEEL
FRAMES 2 TO 12
FRAMES 1 & 13
3/4" DRAIN HOLE THIS END ONLY
FILLER BLOCKS
OARLOCK POST
BRACES
KEEL
BREASTHOOK
14'-7 3/4"
SEAT
FOOT REST
OAR
1/8" INSULATED WIRE
TRACK STOP
FLOOR BOARD
SHEAVE & FRAME
SEAT TRACK
CASTLE STRINGER
CASTLE STRINGER
SECTION THROUGH SEAT
1/4" DIA. BOLT, WASHERS, AND WING NUT
ADD SUPERSTRUCTURE BRACING AFTER CANVASING HULL
BRACES ON ℄
KEEL
STRINGERS
STEM 2" SQUARES
10-OZ. DUCK
1" SQUARES
BREASTHOOK-FOUR REQ.



Kerfing may help in bending hull stringers fore and aft. Clamps hold them while the glue sets.



Oarlocks are made from steel rod and are seated in ½" I.D. steel tubing wedged in the oarlock posts.

by 74" panel of waterproof ¼" fir plywood. Use well-seasoned lumber to avoid warping.

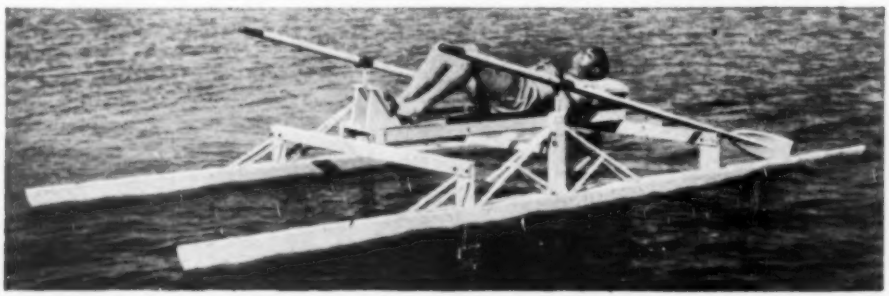
The construction is straightforward, with all joints fastened by waterproof plastic glue and nails or screws. Don't attempt to bend the ends of the hull stringers until all are in place and the stems and keels attached. Then try them in pairs by hand, and if there appears to be danger of splitting or cracking, make a few judicious saw kerfs on the inside faces and try again. When all seems safe, glue and clamp.

Cover each hull surface with a separate oversize strip of canvas, gluing from the center toward the ends. Align a strip on the frame, fold it back at the middle, and apply waterproof plastic glue to 12" or so of frame at a time. Work each part with the thumbs until the glue has set to prevent sag. Trim the edges and cover the bottom corners with tape as an aid to waterproofing.

Dampen the hulls with water from an insect sprayer, taking a side at a time, and place in the sun to dry and shrink tight. Then apply three coats of model-airplane dope or, preferably, two coats of full-strength aircraft dope. If further tightening is needed, redope and place the hulls near an electric heater. Finish with two coats of lacquer or good-grade enamel.

Groove the 74" long transverse ties and castle stringers to lessen weight. Fit the grooved ends of the former over frames 4 and 10, drill through, and fasten with corrosion-resistant bolts and wing nuts. Mount the castle stringers with angle braces, and then fit in the oarlock-post transverse brace under the stringers, fastening it with angles to the stringers and to the oarlock posts. Two bolts through each end, with wing nuts, hold the transverse piece to the angles screwed to the oarlock posts.

Screw 56" lengths of ¼" by 1" by 1" duralumin angle parallel on the floor board for seat tracks. Stop the ends with blocks. Micarta sheaves in ball-bearing frames, available as aircraft surplus, make seat wheels. Row with 9½' to 10' spoon oars. END



A good place for a snooze. Oars are parked with the blades on the hulls. The padded seat is a pillow.

A duckboard platform, built of smooth scrap lumber, helps keep wet feet from carrying mud into the pool.

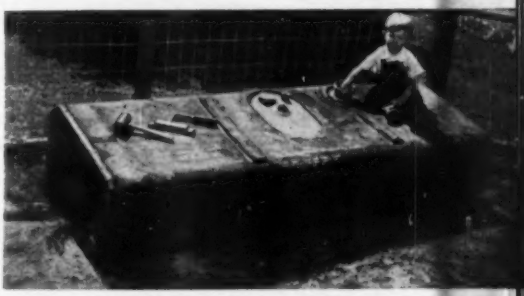
Bomber Tank Becomes Wading Pool

WARPLANE wing tanks, which can be picked up as war surplus for about $5, make excellent back-yard wading pools. The pool shown was cut from a wing tank made for a B-17 bomber. It was laminated neoprene and cloth and required a couple of hours of cutting time, but it was so stiff that no frame was needed for rigidity.

A line was scribed around the sides and ends about 7½" from the bottom as a guide line After several unsuccessful attempts, a linoleum knife tapped on the back of the blade with a wooden mallet was found the best means of cutting. Wedges inserted as the cutting proceeded helped to speed the work, and the hooked point of the knife got a good grip under the material.

The top half of the tank with the filling hole in it was discarded, as was a thin baffle inside that was easily cut loose. An aluminum gas elbow at the outlet in one corner was left in. This keeps the water level at about 2". It could easily be plugged to make the water level higher

A duckboard platform was built around the pool. Filling is accomplished with the garden hose. When the tank needs cleaning, it can be propped up on one end and hosed out.—GERALD F. KOEPPLINGER.

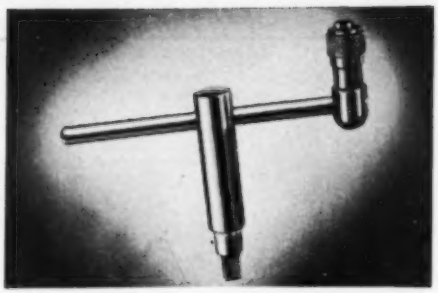


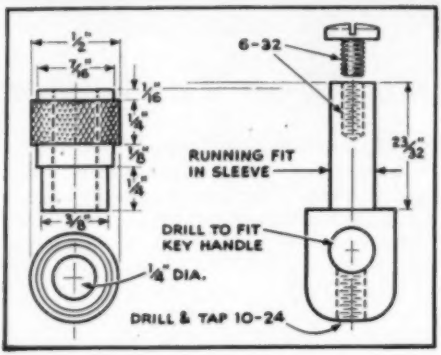
Here's how the wing tank looks before conversion. The line is scribed for a guide during the cutting.

Cutting through ½" of neoprened cloth is not an easy job. It was done with a linoleum knife and mallet.

Only the bottom half of the tank is needed. It is smooth except for the outlet shown in the corner.

NEW SHOP IDEAS





SPINNER SPEEDS CHUCKING. With a spinner crank fitted to your lathe-chuck key, you can turn the chuck jaws to position much more quickly. It's particularly useful in reversing the jaws of a four-jaw or independent chuck.

Turn the two parts of the handle from cold-rolled stock. Drill one to fit the cross-piece of your particular key handle, and drill and tap the other end to receive the cap screw that retains the sleeve. The latter is knurled and drilled for a running fit. A hollow-head setscrew holds the unit on the key handle.—HENRY HANSCOM.

COATED ABRASIVES, I [SHOP METHODS]

Abrasives held on a paper, cloth, or combination backing with glue are referred to as "coated abrasives." Three natural abrasives, flint, emery, and garnet, are employed, and two electric-furnace abrasives, aluminum oxide and silicon carbide. Crocus, used only in fine polishing, is oxide of iron, or iron rust, and is obtained as a residue in the manufacture of sulphuric acid. Aluminum oxide, silicon carbide, and garnet are classed as "technical" and are production materials frequently used on power machines; flint and emery are "nontechnical" and are used by hand.

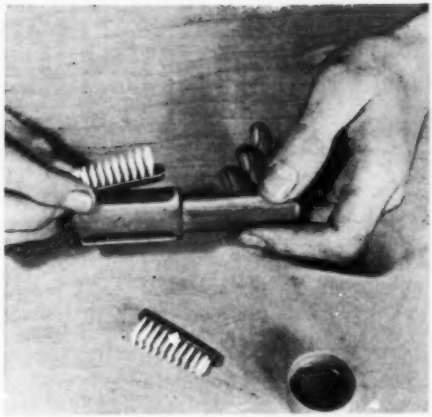
Though abrasives are known by dozens of trade names, manufacturers have adopted the same standards. All aluminum oxide grit used is brown, silicon carbide is black, garnet is red, flint is off-white, emery is black, and crocus is reddish brown. Cloth backings are brown for aluminum oxide intended for metal working; silicon carbide and emery cloth backings are blue; all backings for woodworking abrasives are white; papers are natural color; and combinations show the natural color of the paper. Identifying stripes, when they appear on the backing, are also uniform—yellow for aluminum oxide, blue for silicon carbide, orange for garnet, green for flint, and red for emery.

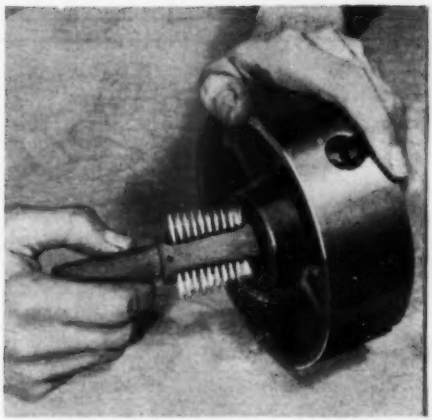
Aluminum oxide and silicon carbide are graded by screen numbers, that is, the number of apertures per linear inch in both directions in the screen through which the grit is controlled. The higher the number, the finer the grit. Garnet, flint, and emery have grade numbers such as 3/0 (000) or No. 3, in which the higher numbers mean coarser grit.

Abrasives are also classed as "open coat" and "closed coat" according to how densely the grain is applied on the backing. Open coat is preferred when cuttings adhere to or "fill" the abrasive since there is space for them to stick without covering the cutting surface.

Aluminum oxide, silicon carbide, and garnet are used for "wet" sanding with water or oil as well as for dry sanding. A "waterproof paper" should be specified.

POPULAR SCIENCE MONTHLY SHOP DATA



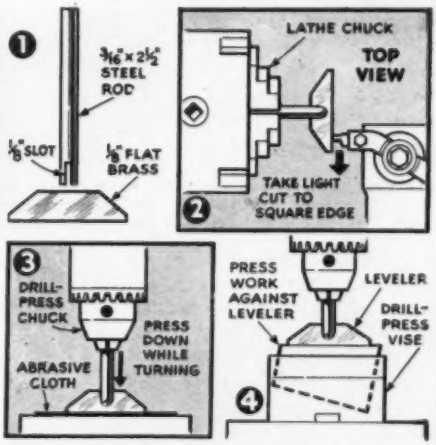


BRUSH CLEANS THREADS. This triple brush does a fast and thorough job of loosening and removing chips from lathe-chuck threads. The holder is hardwood turned to a diameter ¼″ less than the minor diameter of the threads. One end is turned down smaller to serve as a handle. Three grooves are routed in the holder and three straight-contour toothbrushes, with their handles cut off, are glued into place.

MINIATURE SCRATCH GAUGE. A phonograph needle, a few pieces of scrap metal, and 10 minutes time produced this little scratch gauge. You'll find it very handy for small work, especially modelmaking.

A piece of brass ⅜″ by ½″ by 2″ was drilled to allow a 3″ length of ¼″ rod to slide through easily, and a thread was tapped in the top of the block for a 3/16″ setscrew. A hole one drill size smaller than the phonograph needle was drilled near the end of the rod and the needle pressed in.

TAILSTOCK CENTERS WORK. A short piece of rod or a partly finished turning can be centered in a lathe with remarkable accuracy if you use the tailstock chuck to "hand it over" to the headstock. Put the piece in the tailstock, slide it up to the headstock, tighten the three-jaw chuck, and then release the tailstock chuck.



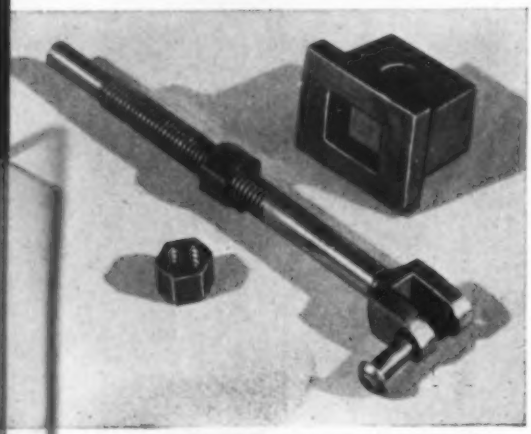
DRILL-PRESS WORK LEVELER. This gadget will quickly level irregular work in a drill-press vise so a hole can be drilled at exactly right angles to the surface.

Cut a ⅛″ slot in a 3/16″ by 2½″ steel rod to fit a small straightedge made of ⅛″ flat brass (Fig. 1.). Solder these pieces as square as possible, chuck the rod in a lathe (Fig. 2), and take a light cut to true the bottom of the straightedge. You can also true it by revolving it in a drill press at medium speed against abrasive cloth (Fig. 3). How the leveler is used is illustrated in Fig. 4.—Herbert Pfister.

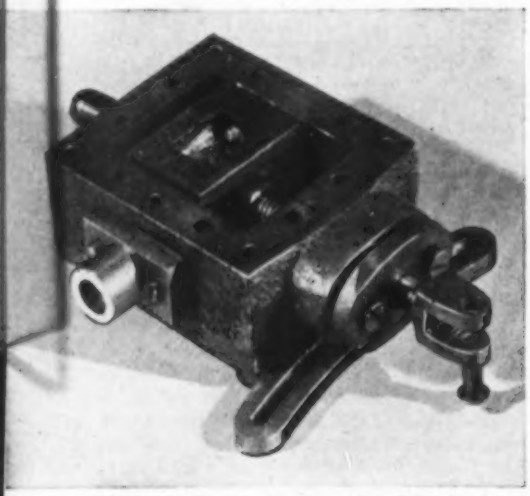
Vertical Steam Engine PART FOUR

Here's the finished job as she'll look when you make the parts described in this last installment

Building the



The slide valve is located on the valve rod by a pair of locking nuts that provide travel adjustment. The nuts must be a tight fit on the thread.



Steam chest and valve assembly. The valve is not clamped snugly but floats between the nuts so that steam pressure can hold it against the port face.

AT ONCE the most fascinating and the most difficult part of this engine to build, the reverse gear is derived from Stephenson's famous link motion. The valve rod, which moves the slide valve over the ports, is not connected directly to an eccentric at all, but to a small block that slides in a slotted quadrant or link. Two eccentrics, oppositely offset to give the correct advance for both forward and reverse running, are connected to the two ends of this link. A control lever connected through a drag link can shift the slotted quadrant and its connecting eccentric rods one way or the other, bringing the link block and consequently the valve into line with either the forward or the backward eccentric, and so determining which way the engine will run.

When the link block is midway in the slot, no motion is imparted to the valve even if the crankshaft is turning, and the engine will soon stop. Either side of this position, though, the valve will operate with reduced travel. Steam will be cut off during a greater part of the stroke, saving on fuel, a condition analogous to high gear in an automobile transmission and precisely that which obtains in a steam locomotive running at high speed with a moderate load.

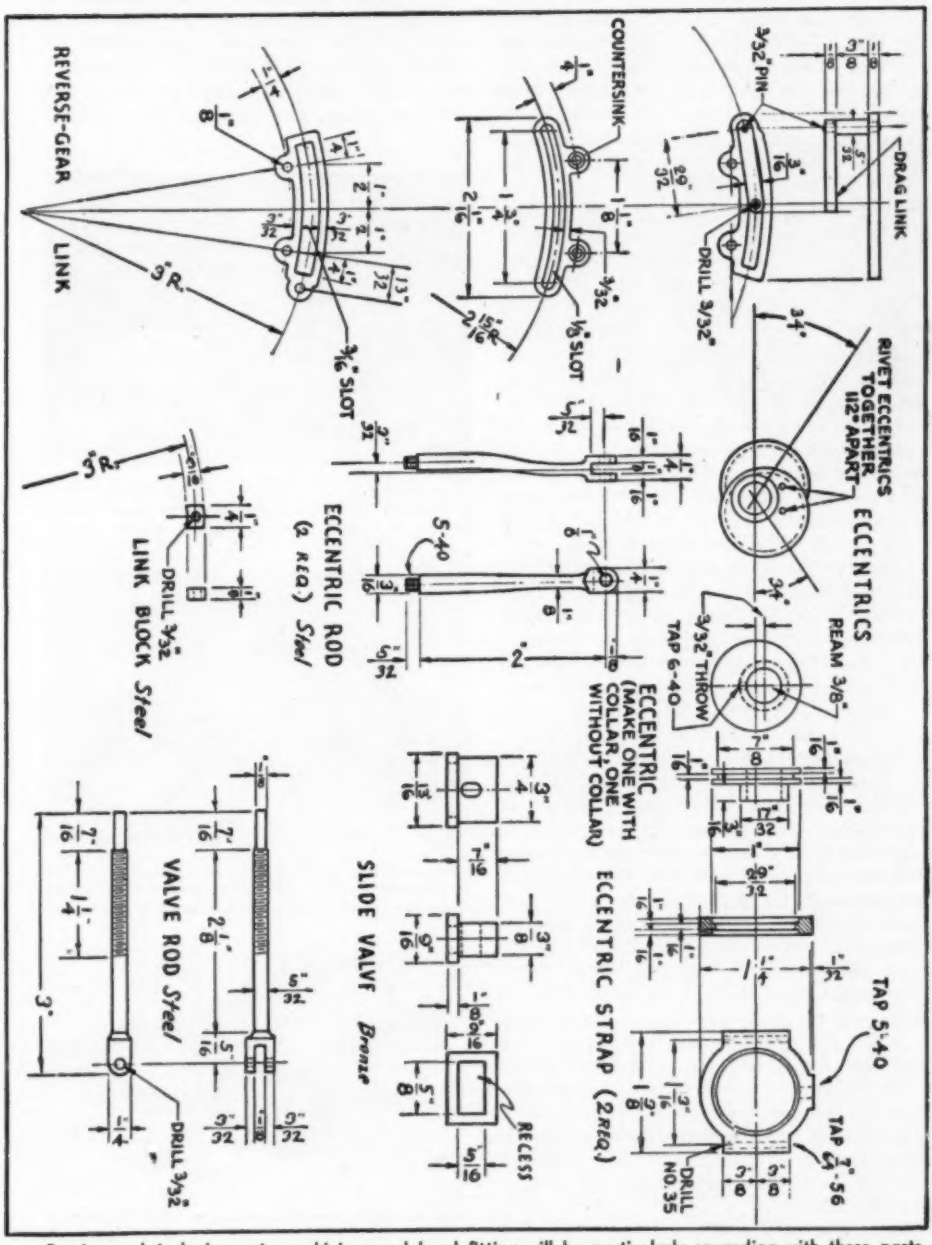
The slide valve consists of two pieces of bronze, the face a piece of ⅛" plate in which a rectangle is cut by drilling and filing to form the steam cavity or recess. To this is silver-soldered a bronze block. The hole for the valve rod is filed slightly oval with a needle file so that the valve has some slight play against the port face and may be held on it firmly by steam pressure.

Turn the valve rod from 5/16" square steel rod, shouldering the end to a sliding fit in the guide atop the steam chest and threading the stem with some fine thread such as 8-36 or 6-40. Drill the square end for the 3/32" pin that will connect it to the link block, cut the slot, and file to shape.

Eccentrics can be turned from short ends of stock. Chuck a piece 3/32" off center, turn the hub, and drill and ream the ⅜" shaft hole. Then chuck the piece truly in the three jaw to turn the 1" outside diameter and the ⅞" groove, and cut off. Make a second eccentric with no hub. *[Turn the page.]*

Reverse Gear

By C. W. Woodson



Precise work in laying out, machining, and hand fitting will be particularly rewarding with these parts.

Face both smooth, slip them on a short piece of ⅜" rod, and rivet together at exactly the angle shown in the drawings.

To make the eccentric straps, cut two pieces 1⅝" long from 3/16" by ⅝" cold-rolled steel for each strap. Lay out, drill, and tap the bolt holes for fastening the two halves together. Those in the lower half are drilled out to clear the 7/64" bolts. With the halves bolted together, each blank is chucked and bored to a running fit on its eccentric. The outside is then roughly sawed and brought to final shape by hand filing.

Eccentric rods are turned from ¼" square steel. They should be cut slightly long to allow for shortening in the bend. Lay out the hole in the fork end after bending, measuring from the shoulder at the threaded end. Drill, slot, and file the fork to shape.

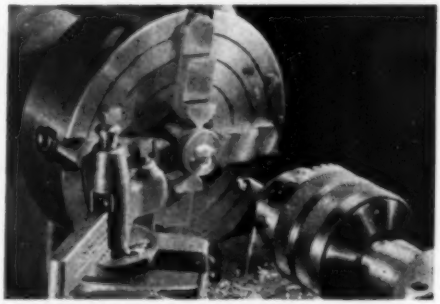
With dividers, carefully lay out the reverse link on ⅛" steel plate. To make the slot, drill a series of undersized holes, drill between to overlap them, and finally file to the radiuses. Drill for the eccentric-rod pins and finish the outside by filing to shape. Note that the link block has sides of the same curvature as the link slot, in which it should be a perfect sliding fit, without play.

The reverse lever and its quadrant, drag link, and clamping nut offer no special difficulties. With the various short pins and the valve-rod nuts, you are ready to assemble the valve gear. One of the photos shows it in a trial assembly, less the reverse lever.

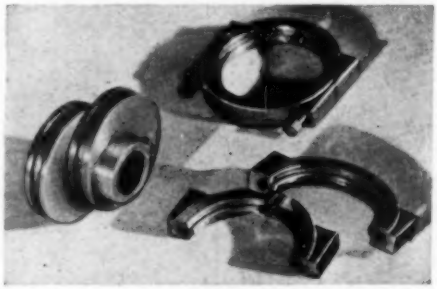
Assemble the steam chest, valve, valve rod and adjusting nuts, and gland as in the photo on page 174. Be sure the valve rides freely on the rod so that its face may be lifted a trifle above the bolting surface of the chest in the position shown—enough to allow for more than the thickness of a gasket between chest and port face. To allow full contact with the port face, the adjustment nuts should be drawn up only to position the valve, not to clamp it. Either tap the nuts somewhat less than full thread depth for a tight fit on the rod, or make two thin nuts out of each one to provide locking.

With the cylinder and running gear assembled, mount the steam chest temporarily without the cover and connect the eccentric rods to the link. Set the two eccentrics on the shaft so that the crankpin throw bisects the angle between the eccentrics. You can then observe the valve travel by turning the crankshaft.

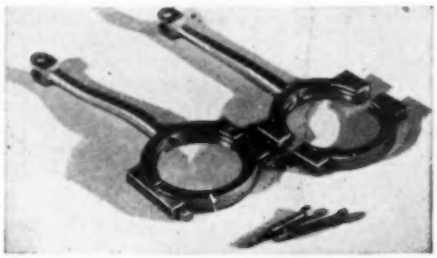
Steam ports should just begin to open as the piston reaches top or bottom dead center. The valve should uncover both ports to an equal degree, and at no point expose the exhaust port. These conditions will best be observed at full forward and full reverse setting, with the link block at the two ends of the slot. At intermediate positions valve travel will be shortened, and cutoff—the closing of the port last admitting steam—will occur earlier in the stroke. If setting the valve nuts does not correct valve travel, it



Each eccentric is turned separately. Round stock is chucked 3/32" off center and the shaft hole is drilled. It is then centered and the outside turned.



The eccentrics, one without a hub, are then riveted or pinned together. After each pair of strap halves is bolted together, the inside diameters are bored.

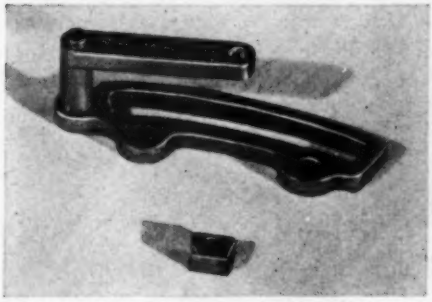


One or both eccentric rods are offset slightly so as to bring the centerlines of their forks directly over the centerline of the assembled eccentric.

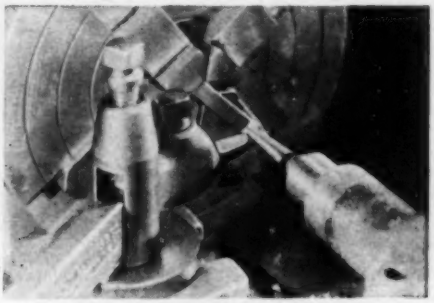
may be necessary to reset the eccentrics, or even shorten or lengthen their rods.

Assemble the engine, using oil freely on all moving parts, with gaskets and graphited gland packing. Run it in at low speed on steam or air, or by outside power, until the parts have worn to a good fit and lost any initial tightness. The steam line should have a lubricator to oil the cylinder.

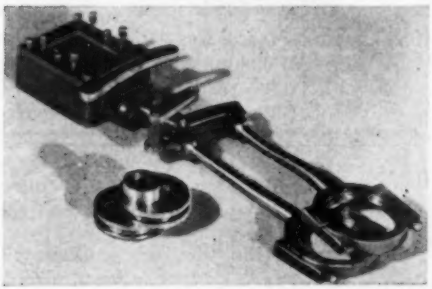
Beware the temptation to throw over the reverse lever at high speed. While the engine should stop at mid-quadrant setting, you'll want a throttle valve for fuller control. It's well to add asbestos lagging and a sheet-metal jacket to the cylinder to minimize condensation, and to start up slowly until the cylinder is hot and any condensate has escaped via the exhaust. Being of cast iron, the engine will safely stand pressures up to 100 lb. END



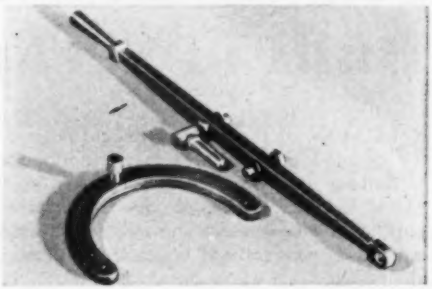
A short pivot stud connects the drag link to the reverse link. Also above is the link block, shaped to match the slot, which fits the valve-rod fork.



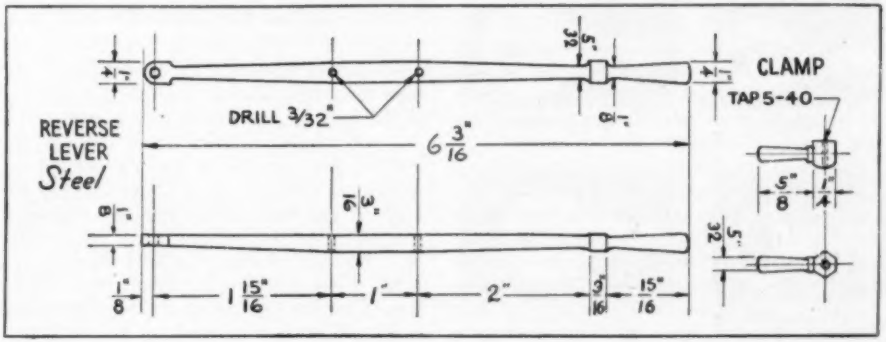
Chucked in the four-jaw, a piece of 1/4" square steel is turned down to form the handle of the reverse lever. Holes must be located as in the drawing.

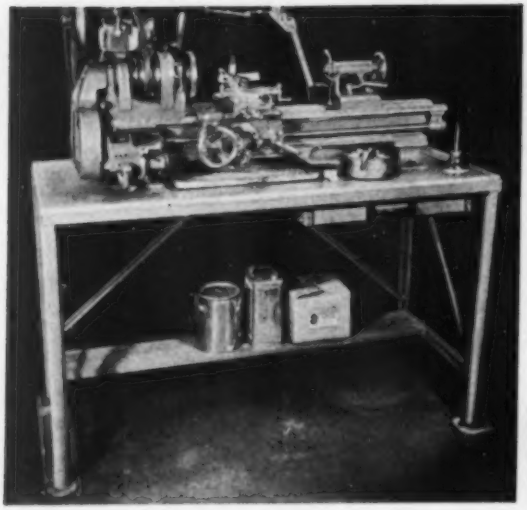


How the reverse gear will be assembled on the engine. The quadrant on the steam chest receives the clamp screw that locks the reverse-lever setting.

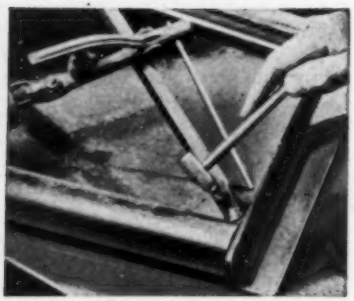


At its lower end, the lever pivots on a stud that screws into the ring, which will itself be bolted to the base. The clamp nut is fitted with a handle.

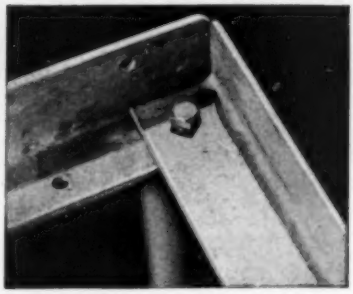




Lathes and other shop machinery can be mounted on such a metal bench as this. Only the shelf and top are of wood.



Both end sections are welded up as single units. Chip off the scale after welding to provide an even painting surface.



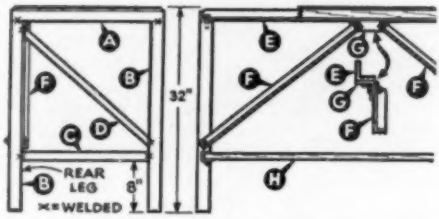
Angles form a frame for the bench top. A filler strip is needed over angle A, the thickness of the iron in E.

Sturdy Bench Built of Scrap

BECAUSE of the high price and scarcity of suitable lumber, you may find it better to build a shop workbench from scrap iron. Metal for this one, made for a 9″ lathe, cost $2 at a junkyard. The only wood used was the 2″ pine top ($3.50) and the 1″ pine shelf ($1).

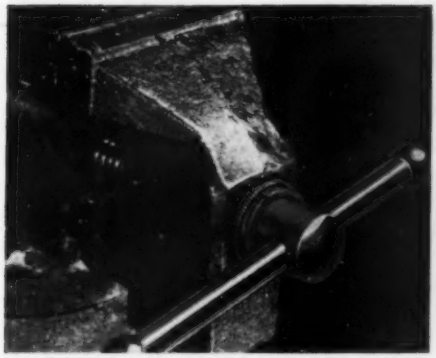
All the metal pieces are lettered in the drawing: *A*, two 1½″ by 1½″ by 24″ angle irons: *B*, four 30″ lengths of 1½″ pipe; *C*, two 1¾″ by 21″ angle irons; *D*, two 30″ lengths of ¾″ O.D. tube (or rod); *E*, two 1½″ by 1½″ by 53½″ angle irons (such as old bed rails). The braces *F* can be smaller angle stock, channel, rod, or tubing. *G* is a 6″ length of angle providing attachment for rear braces F. The 8″ shelf *H* adds longitudinal rigidity, being bolted to members *C*.

Weld or braze the end sections at the joints marked *X* in the drawing; this makes the two ends rigid units, to which the longitudinal members should be bolted rather than welded to permit disassembly and flat storage. As a photo shows, a machine bolt through piece *E* may be screwed into a tapped hole in piece *A*. Alternatively, the pipe leg might have a rectangular notch cut at the end for the nut before welding.

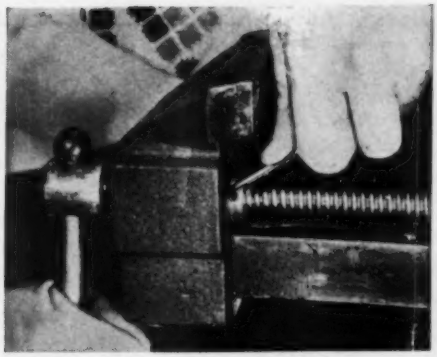


All parts lettered here are pieces of scrap metal with the exception of *H*, which is a board shelf.

If welding or brazing is not feasible, the end frames can be bolted or riveted together, members *A* and *C* overlapping the legs. If the ends of the legs are threaded, standard pipe floor flanges can be screwed on. Besides affording a firm footing and holes for floor-mounting bolts, they can be turned on the threads to compensate for an uneven floor and to level the bench.



A thrust bearing gives a far stronger grip to this vise. The coil spring retains a leather dust guard.

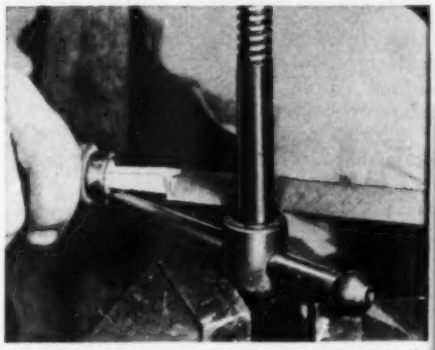


To install the bearing, remove the hand screw by releasing the retaining collar between the jaws.

Thrust Bearing Improves Vise

BECAUSE of reduced friction, a ball thrust bearing will greatly increase the grip of a vise. But even when the jaws are under maximum pressure, a slight pull on the screw handle will release them, enabling you to work with greater speed and ease.

Suitable thrust bearings, obtainable at many hardware stores, can be easily installed. Remove the screw from the vise by releasing the retaining collar between the jaws. Clean it and the rest of the vise in a kerosene bath. If the thrust shoulder on the screw is badly worn, dress it down to provide a flat, even seat for the bearing. If the thrust plate on the movable jaw is badly worn, it may have to be counterbored slightly. Slip the bearing over the screw, reassemble the vise, and wrap a piece of oil-soaked leather over the bearing, securing it with a small coil spring stretched and then hooked together. This will keep dust and filings out of the bearing.—EVAN P. JOHNSON.

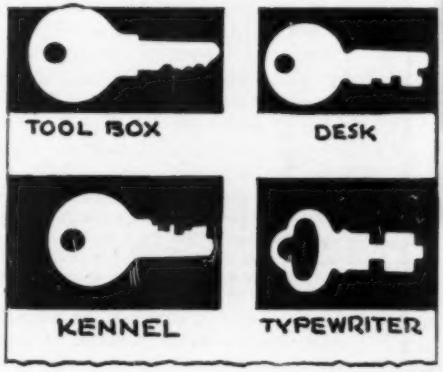


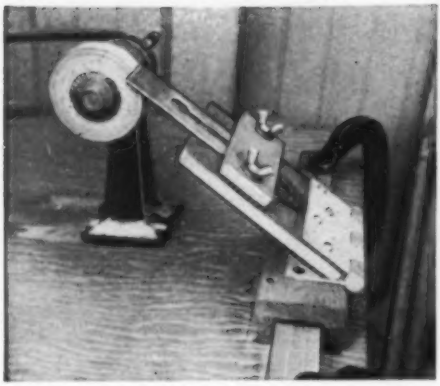
If the thrust shoulder is badly worn, file it flat to provide an even seat for the new bearing race.

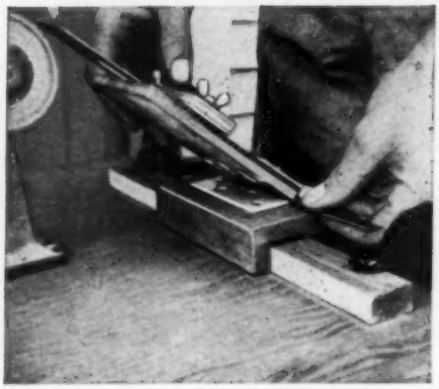
Shadowgraphs Make It Easier to Identify or Duplicate a Key

COMPLETE records of your keys in shadowgraph form may come in handy in two ways. If you want to identify a key from a miscellaneous batch, match it against the graph and you have the answer. If you need a duplicate, the information is at hand.

Arrange your keys on a sheet of blueprint or photographic paper in subdued light, lay strips of cardboard crosswise to leave white areas for labelling, expose by turning on a white light about 60″ above the paper, and process as directed. When the paper is dry, label each key according to its use, and record the trade name and serial number of the key underneath.—E. CHRISTENSEN.



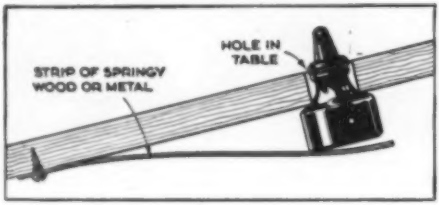




Adjustable Guide Helps Grind Perfect Edge on Cutting Tools

BUILT around a door hinge, this simple guide makes it an easy matter to grind a straight cutting edge on a plane blade, chisel, or similar tool.

Accurate transverse movement of the blade during grinding is assured by a U-shaped channel base shifted back and forth on a guiding strip. This is clamped to the top of the workbench parallel to the grinding-wheel shaft. A shim placed in the hinge as at right above adjusts the blade at any desired angle.—GUY H. LEARNED.



Ink Held Under Drawing Board

A BOTTLE of ink installed under a drawing board in this manner is out of the way and safe from spilling. Thrust the neck up through a hole, and support the bottle with a stiff flat spring attached under the board with one screw.—ERIC SLOANE.

TINTING INTERIOR WHITE, I [*PAINTING*]

Off-Whites: For warmth, add a trace of Indian red or Venetian red.

To avoid stark white on ceilings or woodwork, add a trace of raw sienna, or a trace of raw umber and lampblack.

For a cool, faint green cast, add chrome green.

Ivory: Tint with raw sienna and chrome yellow light in varying proportions, with traces of Venetian red and lampblack permissible for still further variety.

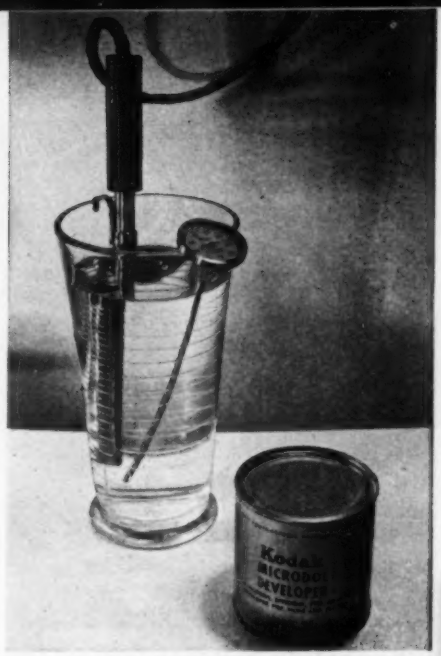
For a good light tone, use 3 parts chrome yellow light to 2 parts raw sienna and just a trace of lampblack.

Cream: Tint with raw sienna and a trace of chrome yellow light. Venetian red substituted for the yellow produces a light tan.

NOTE: Start with a flat wall or interior semigloss or gloss white of the quantity needed for the job, and stir it thoroughly. Then mix small amounts of each oil color with a little turpentine to fluid consistency. Add oil colors, a little at a time, to the white, stirring thoroughly after each addition. Be wary of using too much color; tones are easily darkened, but they cannot be made lighter without waste.

POPULAR SCIENCE MONTHLY SHOP DATA

Small Immersion Heater Warms Solutions



Built around the heating element from a soldering iron, this immersion heater quickly raises a photo solution to the temperature needed for good work.

OFTEN it is difficult to maintain photographic solutions at the proper temperature, and yet the right temperature is important for good print quality, particularly in home-processed color work. This pencil-type immersion heater will warm a solution, either in a tank or bottle, at the rate of one degree per minute per quart. You also can use it for heating water to dissolve chemicals.

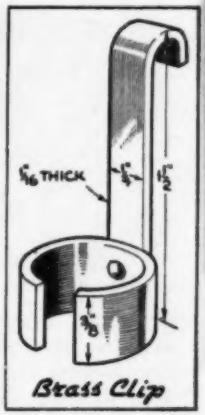
Remove the plug from the cord of a 60-watt soldering iron, unscrew the tip of the iron, and pull out the element and cord. It is best to remove the plug, for the cord and resistance element are sometimes connected with clips that are difficult to rejoin. Then drill one end of a 12″ length of ¼″ (9/16″ o.d.) brass pipe to 7/16″ diameter for a depth of 4″ to accommodate the heating coil. Also tap this end with a ¼″ pipe tap.

Insert the resistance element into the pipe and seal the end with a ¼″ pipe plug and white lead or sealing compound. Test the watertightness of the plug by immersing this end in water for several hours. A clip is made by riveting a U-shaped hook to a ⅜″ piece of ¼″ pipe that has been cut and opened to fit over the longer pipe. A 3½″ piece of ribbed garden hose provides an insulated handle.

Immerse the heater before plugging it in. This will lessen the possibility of breaking the fireclay in which the resistance wire is embedded. If the unit is first used in some old film hypo, the brass will acquire a coating of silver.—FRANK MCCARTY.

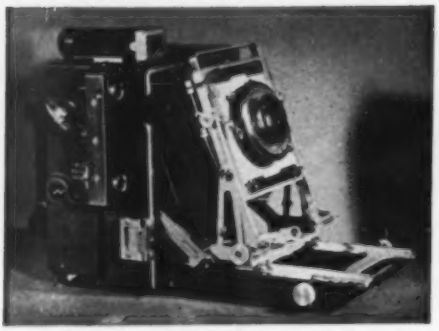
After enlarging the inside diameter of a 12″ length of ¼″ brass pipe for 4″ at one end, insert the resistance element from a 60-watt soldering iron.

Tap this end of the pipe, and seal with a ¼″ pipe plug and white lead to keep it watertight. Garden hose on the end makes an insulated handle.

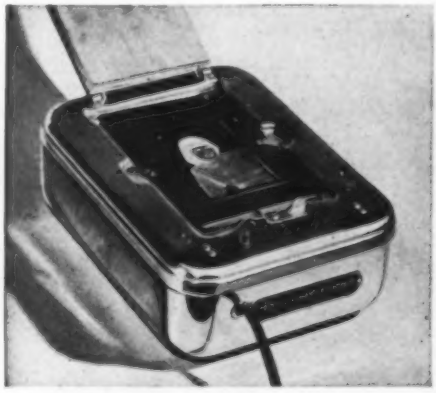


For the clip, cut and spread apart a piece of ¼″ pipe. Rivet this to the hook.

PHOTO IDEAS and EQUIPMENT

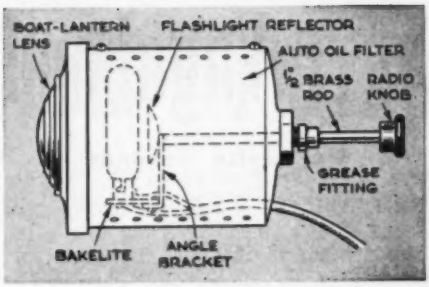


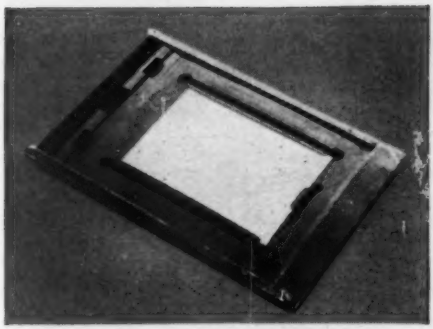
NEW GRAFLEX CAMERAS. A completely redesigned Speed Graphic and a new Crown Graphic have been announced. Each is being made in the three popular film sizes —2¼" by 3¼", 3¼" by 4¼", and 4" by 5"— and both are grouped in what is to be known as the Pacemaker series. The Speed Graphic has an entirely new governor-controlled focal-plane shutter set with a one-key selector instead of two keys as in the past. A body release trips either the front or back shutter; a new front provides tilt, rise, and lateral lens adjustment; and an open-frame finder can be corrected for parallax. The Crown Graphic has all the Speed Graphic improvements with the exception of the focal-plane shutter. There will be about a $30 price difference between them.



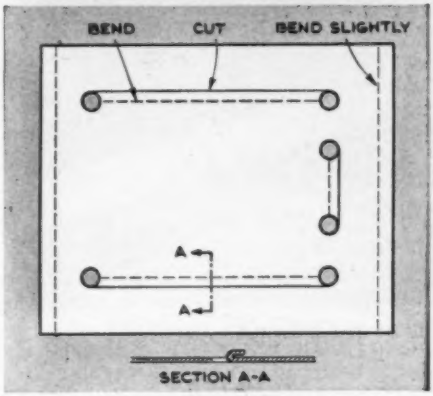
AUTOMATIC CONTACT PRINTING. Exposures are measured accurately with a built-in flashing timer in the Abbey Flash Printer, a small, 22-oz. device that gives post-card size prints. With a No. 3 or No. 4 paper, the printer can be used in a normally lighted room without fogging. Abbey Photo Corp., of New York, lists it at under $9.

INDIVIDUAL PORTFOLIOS. To keep unmounted prints in good condition, and those of one subject or related subjects together, folders big enough for 11" by 14" enlargements can be made cheaply of corrugated board. Tape two sheets together on one edge. A print pasted on the cover both decorates and identifies a folder.—ROBERT J. METZ.



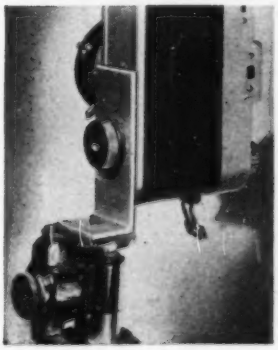


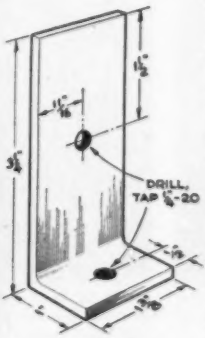
HOMEMADE ADJUSTABLE SPOT. All parts of this spotlight came from the shop junk box except the lens, which was from a boat signal lamp. The housing is an auto oil-filter case with a threaded cap, in which a hole was cut for the lens. A grease fitting was drilled out as a sleeve for the rod that carries the lamp assembly. Moving this varies the beam from a small spot to a fair-sized flood. Rows of ⅛" holes at top and bottom, fitted with baffles, provide sufficient ventilation.—Floyd E. Freeman.



CAMERA BELT HOOK. When a small camera not equipped with a carrying case is taken on a hike, a hook attaching it to your belt will leave both hands free. The hook can be bent from stiff sheet metal. One end is shaped to slip over the belt, while the other is bent tightly around the handle grip. When not needed, the hook can be taken off the handle with a pair of pliers.

HOLDER FOR UNDERSIZE FILM. You can use cut film smaller than your holders with a sheath made from 1/64" sheet brass or tin plate. Drill where the corners of the film will come, saw between the holes with a jeweler's saw, and fold toward the center over a spacer somewhat thicker than the film. A shorter slot is similarly formed at one end. Paint the metal dull black, and use the sheath as an insert in your regular film holder.—Karl Haller.





TRIPOD ADAPTER. Because miniature cameras usually have only one tripod-screw socket, many pictures that call for vertical framing have to be taken with the camera supported for horizontal framing. An adapter can be made from aluminum, brass, or steel angle to support the camera vertically. Drill and tap both legs for a standard ¼"-20 camera thread. Screw the short leg to the tripod and attach the camera to the other leg with the knurled-head bolt that is used for fastening it in place in the carrying case.—George Frost.

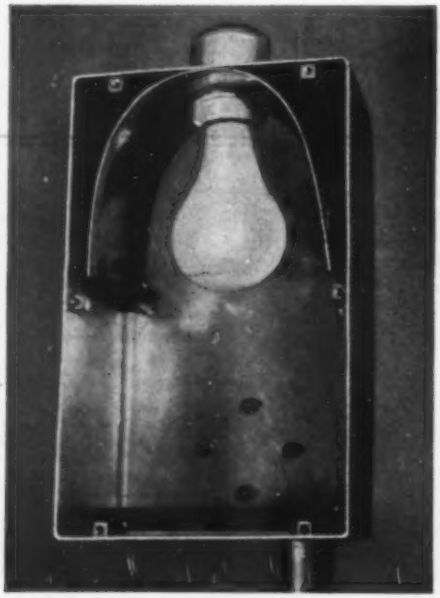
CLAMP THE ENLARGER ANYWHERE. Attached to a window sash, it is adjusted quickly for height.

Vagabond

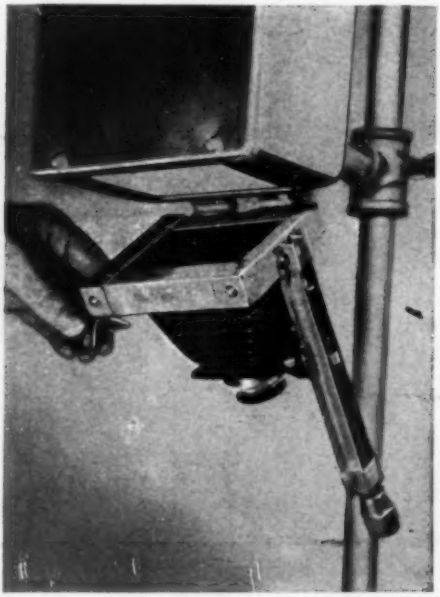
By Leslie Sargent

PORTABILITY is a feature seldom associated with an enlarger, but that is the biggest asset of this one. Designed particularly for the kitchen-table darkroom, it can be quickly assembled and put into use anywhere—clamped to a door, the back of a chair, or a window sash. Moreover, if you are going on a trip, the entire enlarger may be taken along, the clamping arm, bellows assembly, and a tube or two of developer and paper packed into the lamp house. The whole kit, weighing only 7 lb., goes in a suitcase with your camera, pajamas, and extra shirt. The enlarger handles any negative up to and including 2¼" by 3¼".

Measuring 4" by 6" by 10", the lamp house was built from one of the stamped aluminum cases used for overseas shipments, its lid being held on by machine screws. A sturdy cashbox or tackle box would also do, or a suitable case could be



REFLECTOR IS ALSO BAFFLE. Heat escapes past the ends of the reflector to holes in the top. Heat-absorbing glass protects the negatives.



HINGED BELLOWS ASSEMBLY. Negatives are put in place by swinging the frame down, the assembly normally being held up by two spring hinges.

Enlarger Travels with You

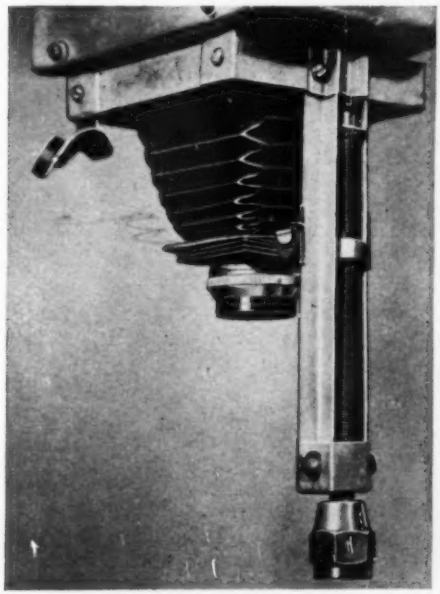
built of sheet aluminum and angle stock.

In one end of the box, cut a hole just large enough for a weatherproof porcelain lamp socket. In the same end, drill several small holes for heat vents. A two-part socket with the halves screwed together from opposite sides of the hole helps hold in place a brightly tinned metal reflector sheet. Make this reflector as wide as the box is deep and about 11″ long, inserting it as an inverted "U." If it is cut from a tin can, leave the bead on the front edge as a protection for your hands. Cut at least two tabs on the back for fastening to the case with small bolts. The reflector also doubles as a light trap, its ends being positioned ¾″ from the sides of the box to allow heat to rise and escape through the vents. Place a switch in the wire at some distance from the socket to avoid the possibility of jarring.

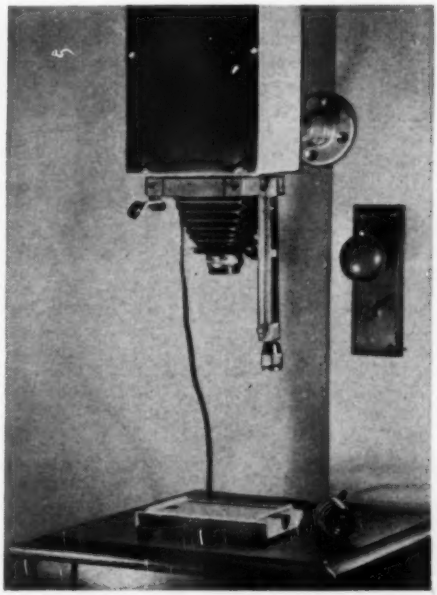
In the other end of the case cut a 2½″ by 3½″ hole and cover it (inside the box) with a piece of opal glass, taping the edges to prevent chipping and to give a snug fit. Above the opal glass, leaving a ½″ air space between, place a piece of heat-absorbing glass, resting it on small bolts installed in the sides of the box.

A rectangular frame to provide a rigid foundation for the bellows assembly may be made of ¾″ by ¾″ dural angle, cut and fitted to leave a negative opening of 2¼″ by 3¼″. Attach the bellows to the frame with flathead bolts, countersinking them into the top to keep the surface smooth for the negative carrier.

At its large end the bellows must be somewhat larger than the negative opening. It should open up to at least a 5″ length. If a suitable bellows is not available from a discarded camera, a camera-supply house, or a dealer in secondhand photographic equipment, one can be made from real or artificial leather, formed in the shape of a rectangular-base truncated pyramid. Crease the sides into pleats so it can be folded in, and



FOCUSING SCREW IS 6″ LONG. This bolt, run through a nut brazed to the lens-board slide, raises or lowers the lens for focusing.



ENLARGER CLAMPED TO DOOR. Two pipe flanges mounted on the support arm with a nipple between them can be clamped tight by a turn.

cement the bellows to the frame and to a slide for the focusing track. The seam may be midway on one side. Make several trial bellows out of stiff paper before cutting the leather, and use the best as a pattern.

Two 6″ lengths of angle bolted to the bellows frame provide a focusing track. It should be positioned to suit the slide on the small end of the bellows. A 6″ long automobile bolt makes an excellent focusing screw. If an automobile bolt is not available, any long bolt having a fine thread can be used. Braze a nut fitting the bolt to the slide on the end of the bellows. Grind or file a knob on the upper end of the bolt and insert it in a bearing cup or collar, such as a window-shade bracket, held to the top of the track by the mounting bolts. Bridge the lower end of the track with a length of strap. Take care in alignment so the screw will lengthen or shorten the bellows smoothly.

With a good f/4.5 lens and a No. 212 enlarging bulb, focusing will be easy and printing pleasantly short, but an f/6.3 lens will serve adequately if you don't mind putting in extra printing time. A lens of 4″ focal length is usually recommended for coverage of a 2¼″ by 3¼″ negative. However, a 3″ lens not only will do a good job, but its shorter focal length will project small negatives well. Mount the lens on a small lens board made of thin plywood or plastic and screw it to the endplate of the bellows.

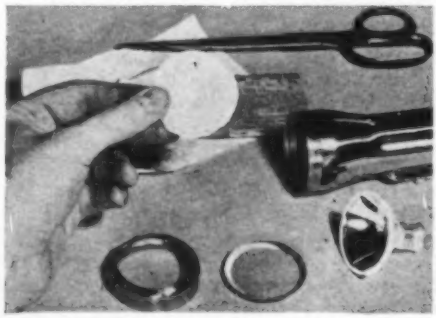
The bellows assembly is attached to the lamp house with two strong spring-type cabinet hinges. Bolt these to the lower back edge of the lamp house and the bellows frame to leave 1/16″ space between the two parts. This provides clearance for the negative carrier. In use, the bellows frame is swung down, the negative and carrier are placed on it, and the spring hinges keep it up while enlargements are being made. A thumb tab at one corner is convenient for pulling the frame down to insert and remove negatives.

Film carriers may be made from tough, thin cardboard or pressed board. Cut the centers from two 3½″ by 4½″ sheets to frame the negative, and hinge one edge with tape. Make a carrier for each negative size to save time.

The supporting arm for the enlarger is a 6″ length of pipe attached to the back of the lamp house by means of a bolted-on flange. A tee and setscrew at the free end provide a method of adjusting the enlarger on a permanent pipe stand. For a portable enlarger, replace the tee with two flanges used base to base. The inner flange should be threaded only part way on the arm so a 2″ pipe nipple can be screwed into its remaining threads to take the outer flange. This arrangement will enable you to clamp the enlarger to a solid support by a simple twist or two. Setscrews may be put through the two flanges to hold them tight. Where there is no danger of outside light spoiling your paper, a window sash will serve as an especially convenient support, for it can be raised or lowered quickly to adjust height. Heavy felt glued on the inside face of both flanges will prevent marring of woodwork.

If you wish to take the enlarger with you on a trip, remove the screws that hold the hinges to the lamp house, unscrew the pipe fittings in the flange on the back, unscrew the lamp socket, and place everything inside the lamp house, protecting the glass and enlarging bulb with packing. Strips of cardboard may also be slipped in the ends to close the holes. Then the lid is screwed down tight or snapped shut, and you are ready to go places. END

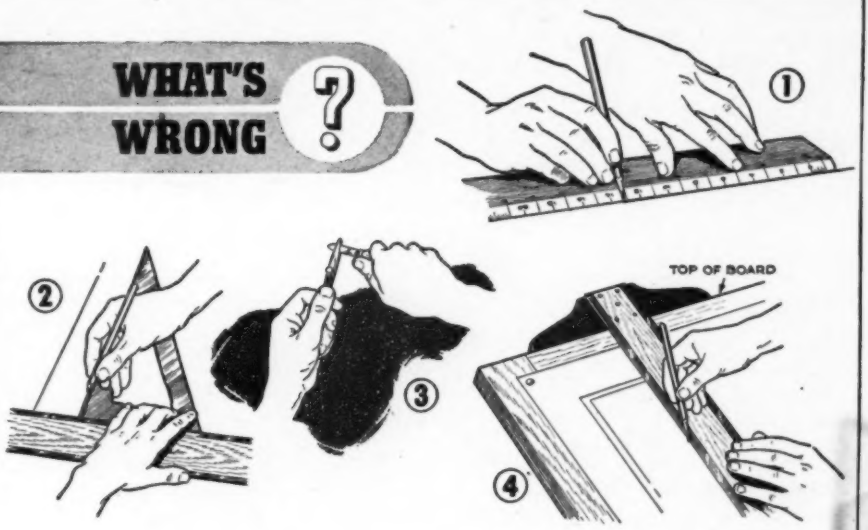
Red Filter Converts Flashlight for Safe Use in Darkroom



CUT round and fitted inside the lens, a red photo filter will convert a flashlight to many safe uses in the darkroom. Such a safelight will be a help in reading instructions and box labels and in hunting things dropped under the sink or tables.

If the disk is cut from a square photographic filter, the protective tissue in which the gelatine is wrapped can be cut along with it and left in place when the disk is inserted. The two layers of tissue will help to cut down the brightness of the flashlight bulb.—R. F. DONAVAN.

WHAT'S WRONG ?



HOME-WORKSHOP owners often need to draw their own plans, and a knowledge of simple drafting procedure is helpful. Five errors are shown in the drawings—two in Fig. 2. Can you spot them?

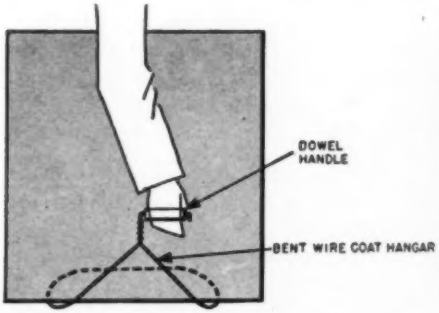
ANSWERS

1. A scale is intended only for measuring, never for use as a straightedge. It may not always be straight, and the practice may wear the graduations.

2. Use the point of the pencil against the straightedge; don't let the lead ride on the upper arris. Also sharpen the lead to a long, tapering point.

3. Scraping inside a ruling pen with a knife will roughen the surface, and the ink may not flow smoothly. Clean it with a cloth before it dries.

4. The sides of a drawing board are made straight and parallel, but the top and bottom may not be square with them. Use a triangle for vertical lines.



Coat Hanger Used as Carrier

DRAWING boards, large portfolios, and the like may be too wide to fit comfortably under the arm. Carrying can be simplified if one is slipped over a bent coat hanger that has been fitted with a dowel handle. The extra length will let the board down low enough to go under the armpit.

Tape Protects Calking Tips

AIR entering the open ends of interchangeable calking-gun tips when they aren't being used may harden the calking material in them. Once this happens, it may be necessary to boil them in a caustic solution. If you cover the ends of the tips with masking tape, the calking material won't harden.

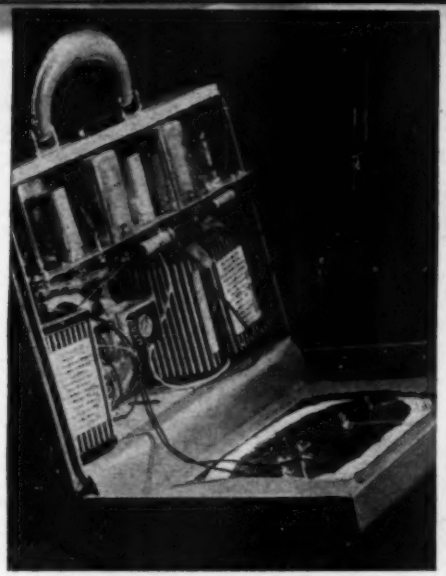
De Luxe Vacation Portable Rivals Console in Tone

By Henry C. Martin

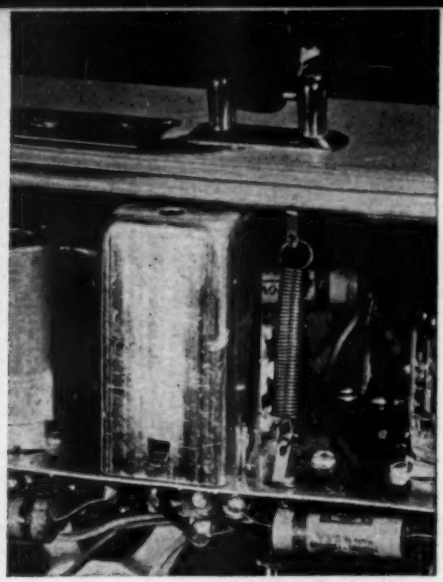
PORTABILITY in radios suggests the great outdoors, yet few manufactured receivers allow for the different requirements of out-of-door as against indoor listening. With the exception of more expensive models, many commercial portables are either incapable of delivering comfortable outdoor volume or else overload to the point of distortion when they are turned up to an adequate level.

These were the chief factors that were kept in mind in the design of this portable. In tone it is equal to many large consoles, while the output level of undistorted volume is high enough to flood a good-sized room. Even where surrounding noise would normally drown out the sound of a radio, you won't have to cock your ear to the loudspeaker of this set. For all its power, it is small enough in size and weight to be easily carried on picnics, beach and boat trips, and the like.

Two 1S4 pentodes are wired in parallel in the output stage and matched to a light permanent-magnet speaker to produce the unusually good tone. The tubes feed into a universal output transformer that has several taps on the voice-coil (or secondary) winding. A transformer with an input capable of matching load impedances up to 4,000 ohms is desirable since that is the theoretical resistance of two 1S4's in parallel. In the original receiver the 2,000-ohm tap was used because it produced the most pleasing tone. The transformer matches this tube impedance to the voice-coil impedance of the speaker which, in this case, is 4 to 6 ohms. The speaker itself is one of the light-



A piece of flat brass, cut to fit snugly across the upper part of the case, is used as a chassis. The lower portion of the cabinet is given over to the speaker and batteries. One 1.5-volt A and two 45-volt B batteries supply the set with power. The loop antenna slips under the lid of the case.



Here's part of the spring-suspension system that helps protect this set from the jolts and bumps that shorten the life of most portables. Anchored between soldering lugs on the chassis and case, two tension springs provide a "floating" or shock-absorbing support for one edge of the chassis.

est 5" units that can now be purchased; its alnico magnet is about as large as a thimble. Weight, of course, is correspondingly small.

The chassis consists of a 3½" by 11" strip of brass approximately 1/16" thick. This piece has no sides but a 2" flange is formed in front to support the dial assembly. By keeping chassis dimensions to a minmum and eliminating the sides, weight is reduced and wiring is made easier. Before cutting the chassis, measure the inside dimensions of the carrying case you intend to use.

Both sensitivity and selectivity are extremely good, the former because two stages of IF are employed, and the latter because in all, eight tuned circuits are used. Tuning is accomplished by means of a midget two-gang tuning condenser. As may be seen in the top photograph on page 191, the plates of the oscillator tracking section are considerably smaller than those of the antenna section. This is because the oscillator automatically tunes to a beat frequency 456 kc. higher than the antenna. As usual, all the IF transformers are adjusted to this fixed 456 kc. intermediate frequency. Incoming siganls go directly to the 1R5 which acts both as first detector and local oscillator.

A pair of 1T4's is utilized for IF amplifiers. Ground return leads of both the interstage and output IF transformers (L4, L5) are wired into the automatic volume control circuit. Manual control of volume is obtained through a 1-meg. variable resistor (R11) in series with the control grid of the 1S5. Detection, or more correctly rectification, is performed by the diode plate within the envelope of the 1S5. The pentode section of the tube acts as the first audio amplifier and is coupled to the detector through R11 and C12. Resistance and condenser coupling is also employed between the first and second audio stages. The latter consists of the pair of 1S4 power pentodes which, in combination, boost the audio signal to the high output level that makes this set so satisfactory.

Final choice of a cabinet will be made on the basis of personal taste, price, and availability. The handsome leather-covered bag shown here is on the expensive side, and many less costly but equally satisfactory substitutes can be found in any luggage store. A small overnight bag will do provided that it is approximately the right size and sturdy enough to stand the wear that portables are subject to. This case measures 4¾" by 8¾" by 11¾" outside; a smaller one is not advisable. Before cutting the case, make cardboard templates of the chassis, speaker, and batteries, and decide on the best position for each of them. Mark the

positions of the volume control and tuning shafts and the openings for the speaker and dial on the outside of the case. Score the leather with a sharp knife, drill the shaft holes, and cut or saw the circular speaker and dial apertures. The edges of the cuts can be concealed by suitable escutcheon plates.

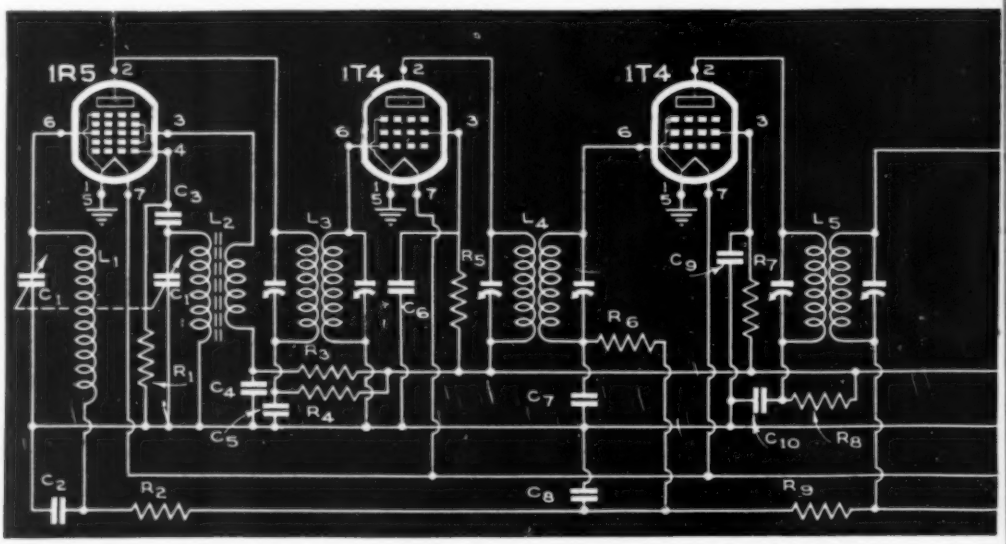
Most overnight bags are fitted with mirrors, and if yours has one it should be removed and the loop antenna slipped under the cover lining. Instead of being mounted rigidly inside the case, the chassis is sprung to absorb jolts and shocks. Two soldering lugs are screwed to the top of the case and another two lugs are bolted to the edge of the chassis. Between the anchor points thus formed, small tension springs are installed to support the rear edge. The front is held only by the shafts, which project through the face of the bag and are gripped by the knobs on the outside.

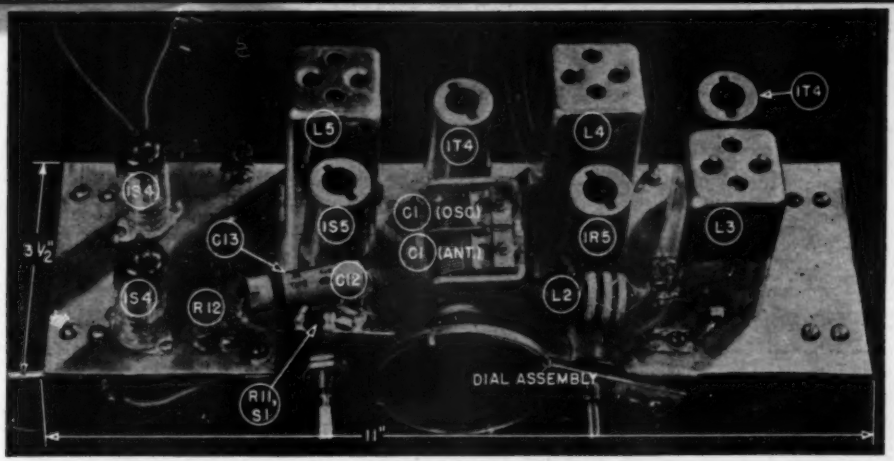
Since, in common with all portables, this set is dependent entirely on its loop antenna for station pickup, it should not be expected to perform any remarkable feats of long-distance reception. It will, however, easily pick up and separate all local stations, and its performance can be improved by using the antenna to best advantage. One way of doing this is to turn the set as you tune it until the position of the antenna favors the station you are trying to get. Reception can also be improved in many cases by leaving the cover of the case slightly ajar. Most loop antennas, in addition, have an extra connection that permits the attachment of an outside aerial when conditions permit.

In order to keep battery drain to a minimum, no pilot light was used in this circuit. This makes it all the more important that you remember to turn off the switch when the set is not in use. If you can't trust your memory, insert a 1.5-volt .06 amp (60 ma.) pilot light behind the dial and wire it in parallel with the tube filaments.

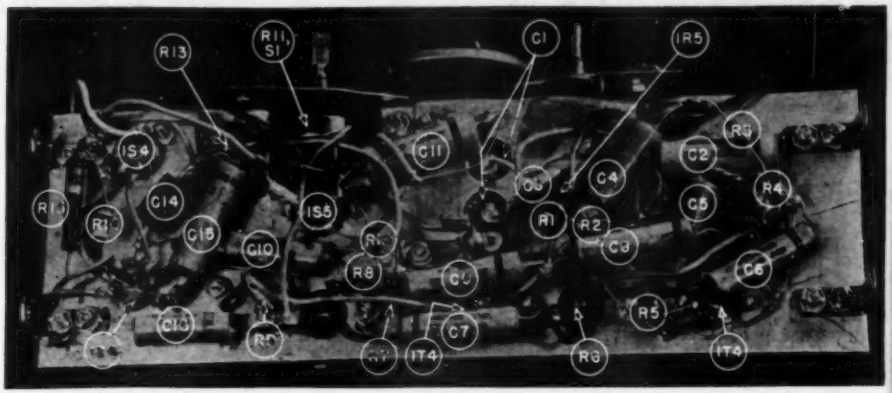
LIST OF PARTS

All resistors ½ watt carbon unless otherwise noted.
R1: 100,000 ohms.
R2: 2 meg.
R3: 10,000 ohms.
R4: 2,000 ohms.
R5: 5,000 ohms.
R6, R9: 5 meg.
R7: 15,000 ohms.
R8: 1,000 ohms.
R10: 3 meg.
R11: 1 meg. with switch pot.
R12: 10 meg.
R13, R14: 1 meg.
R15: 180 ohms, 1 watt.
C1: Two-gang tuning condenser.
C2, C11: .1-mfd., 450-volt paper tubular cond.
C3, C13: .0001 mfd. mica.
C4, C5, C6, C7, C8, C9, C10, C12, C15: .05-mfd., 450-volt paper tubular.
C14: .0002 mfd. mica.
C16: .005-mfd., 450-volt paper tubular.
L1: Loop antenna.
L2: Iron-core oscillator coil.
L3, L4, L5: input, interstage, and output IF transformers.
T1: Midget universal output trans.
S1: D.P.S.T. switch on R11
Speaker, tubes, case, tube sockets, shields, batteries, hardware.

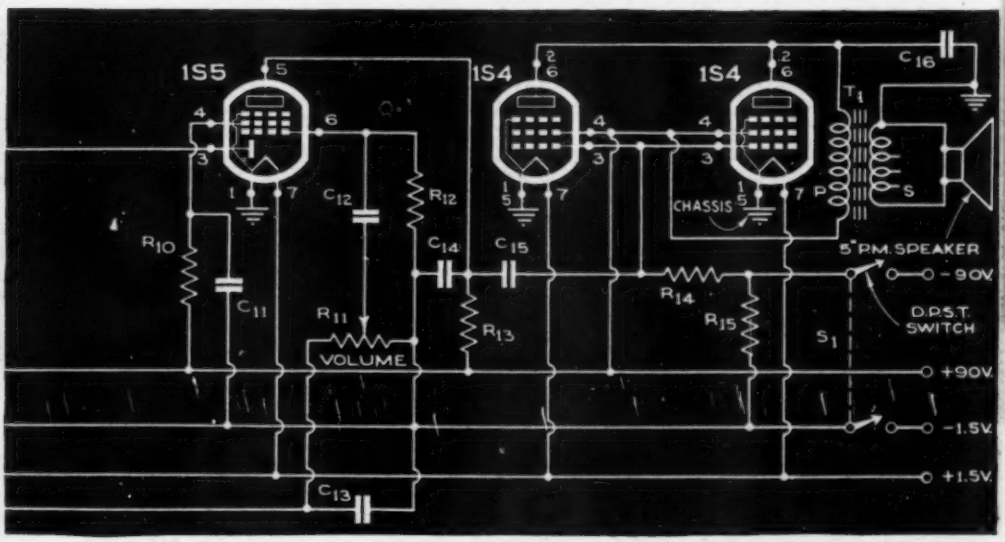




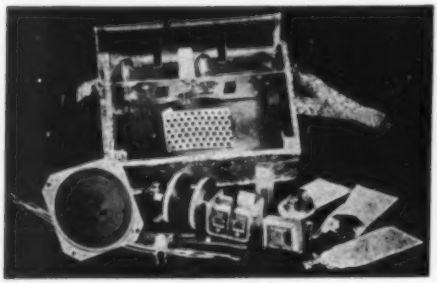
Labeled photograph shows where major parts are placed on top of the chassis for most effective separation.



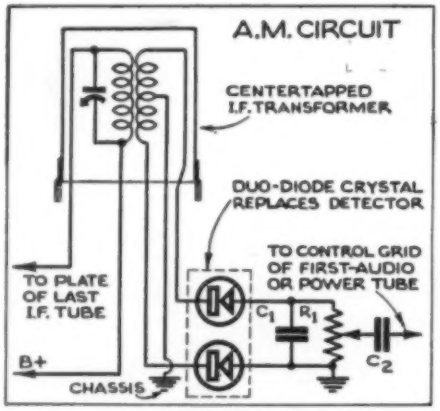
Most of the wiring is done below the chassis. Use the new tiny resistors and condensers to save space.

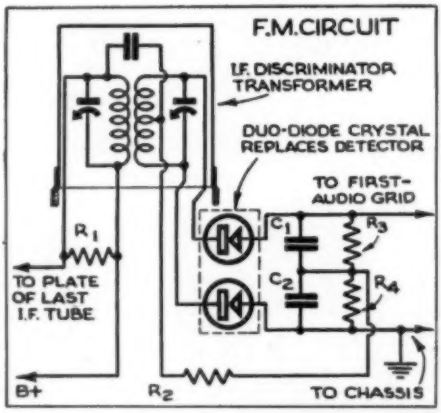


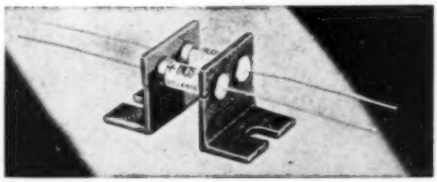
NEWS IN ELECTRONICS



HANDBAG RADIO. Shoulder-strap pocketbooks can please the ear as well as the eye. The complete four-tube superhet handbag shown at right above is made by the ARC Radio Corporation. It weighs less than 5 lb. An identical set is furnished in kit form by the Ubildit Co. Both firms are located in Brooklyn, N. Y.



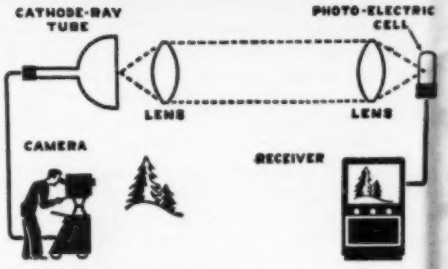


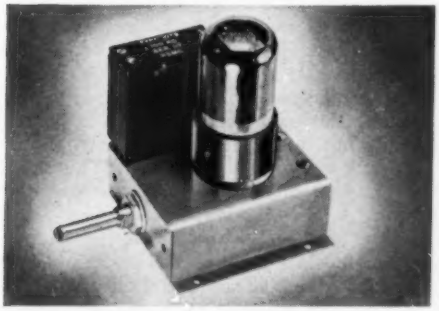


CRYSTAL DUO-DIODE. A new circuit element developed by Sylvania Electric, known as the 1N35, consists of two germanium crystal diodes mounted in one assembly. The crystals are matched for values of forward and back resistance under typical operating conditions.

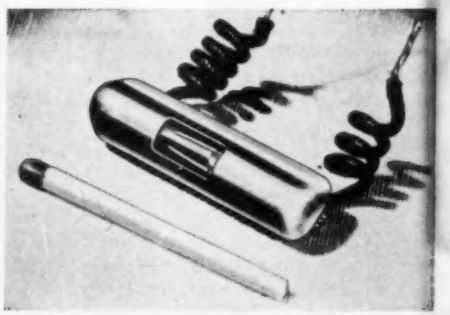
The most likely application of the new device will be in replacing dual diode tubes, such as the 6H6 and 7A6, in standard AM and FM detector circuits. Two typical wiring diagrams, above, show how the crystals may be employed between the IF and first-audio stages of a standard superheterodyne receiver, or following the discriminator transformer of an FM set. The double-crystal unit is also said to be valuable wherever full-wave rectification, modulation, or demodulation may be required in a balanced circuit.

TELEVISION VIA LIGHT BEAMS. High-intensity light beams are being used as carriers for picture and sound signals by the Allen B. Du Mont Laboratories, of Passaic, N. J. For actual broadcasting or in place of coaxial cables for short-range relays, light beams transmit color or black-and-white pictures in light or darkness. A modulated light spot on the screen of a cathode-ray tube at the transmitter is optically focused and beamed at the receiver, which may be several miles away. It is there focused on a photoelectric cell and converted into electrical energy. Output of a photoelectric multiplier is great enough to modulate a picture tube directly, thus offering the possibility that RF and IF stages may be eliminated. The photo at top shows an experimental receiving setup; above, a pictorialized version of how the system works.





CALIBRATION OSCILLATOR. This compact, small-drain unit is built around a 100-kc. crystal and is said to have usable harmonic check points up to 100 mc. Radio Specialty Mfg. Co., of Portland, Ore., makes the device, which sells for less than $15.



NEON PILOT LIGHT. Consuming under 1/10 watt and operating at any voltage from 75 to 250, this miniature lamp is housed in a metal shell especially designed for panel mounting. It is a product of Industrial Devices, Inc., of Edgewater, N. J.

Water Wheel Delivers Over 3 Hp.

With 12 double buckets on a 16" wheel, this homemade impulse-type unit needs only a moderate water flow.

Part Four

By C. D. Bassett

THOUGH one of man's oldest prime movers, a water wheel is still a fascinating piece of machinery. Perhaps this is because it appears comprehensible at a glance (although an efficient wheel is actually a product of subtle and inconspicuous design refinements), and because it seems to be a way of getting power for nothing. The homemade wheel described here was especially designed for this series on harnessing small streams (see PSM for April, May, and June), and will reward a careful craftsman by delivering years of constant service. It's particularly suited for an installation having a moderate head (25′ to 60′) and relatively small flow (.45 to .75 cubic feet per second). Subsequent installments will describe the construction of wheels suited for lesser heads of water and other varied conditions.

As is apparent from the drawings, this is an impulse wheel, driven by the impulses produced as water strikes revolving blades or buckets. In a perfectly designed wheel, the water strikes at high speed, exhausts its energy in driving the wheel to which the bucket is attached, and then falls free of the wheel.

Known as a Pelton wheel, this type developed from the "hurdy gurdy", a paddle wheel used in California by the forty-niners. The hurdy-gurdy was a wheel that rotated in a vertical plane, had flat vanes fixed around its circumference, and was driven by the force of water striking the vanes. It was not an efficient machine, but it was simple to construct. Then an engineer named Lester Pelton substituted a cup-shaped, divided bucket for each of the vanes, and by that step added a high degree of efficiency to the wheel's other virtues.

No single wheel will meet all operating requirements, but some will perform under a reasonably wide range of conditions. The following table indicates the r.p.m. and horsepower output that will be delivered by this wheel under given conditions of head and flow. The latter is measured in cubic feet per second:

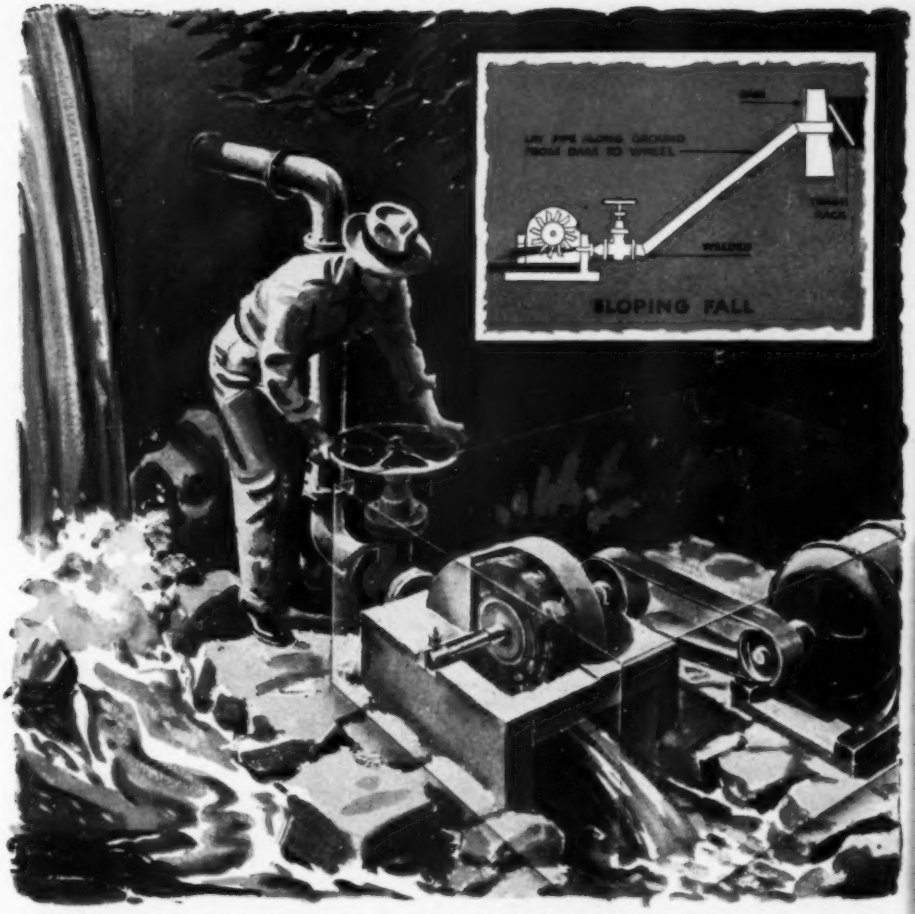
HEAD	FLOW	R.P.M.	HP.
25′	0.43	350	1.0
30′	0.51	390	1.3
40′	0.59	450	2.0
50′	0.66	500	2.8
60′	0.73	550	3.75

Thus, if a survey of your stream indicates a head and flow close to these values, this Pelton wheel will fit neatly into your plans.

Strictly speaking a water wheel is an engine powered by water, just as an automobile engine is powered by gasoline. The important power-producing elements of the wheel are the buckets and the nozzle, and considerable care should be exercised to see that these parts are made correctly. The nozzle meters the correct amount of water to the wheel, and forms and directs the jet against the buckets. Both the inside diameter and the location of the nozzle with respect to the wheel are very important, since the jet must impinge upon each bucket at the correct wheel radius or lever arm. It must also be divided equally by the center ridge of each bucket.

The function of the bucket is to convert the energy of the jet, represented by its high speed, into mechanical energy at the wheel shaft. To do this it must slow the water from its high speed in the jet to practically zero speed when it drops into the tail water. Maximum efficiency with this wheel will be obtained if the buckets have the form and size shown in the drawing. This shape acts to slow the jet by turning it smoothly through 180 deg. The surface of each bucket must be as smooth as possible. A mirror finish is desirable on the inside, and even the back of each bucket should be ground and polished to minimize spray.

Important also is the correct orientation of the bucket to the jet. When the full jet strikes, the bucket should be perpendicular to it. Both the nozzle and the buckets will wear under the action of the high-speed water, at a rate determined by the silt con-



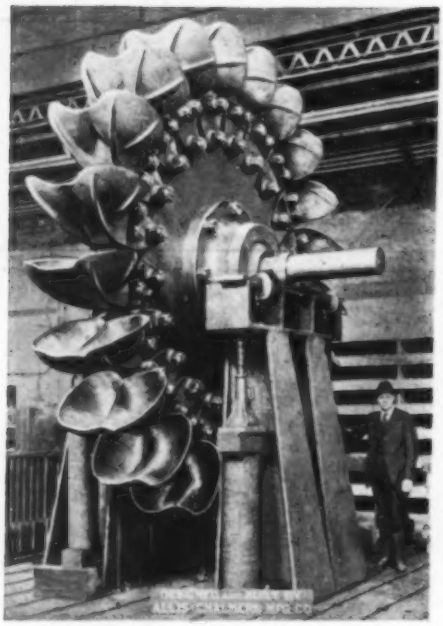
While the penstock may be set up to provide either a precipitous or sloping fall, it should be of as large a diameter as possible, have minimum bends, and hold down flow friction to the least amount.

tent, and should therefore be made easily removable for replacement.

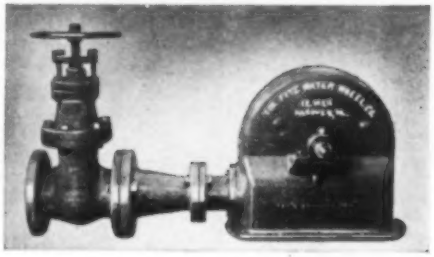
Above all, buckets must be uniform. If you can get access to a metal-cutting bandsaw, cut the blanks according to a single pattern. This pattern can be shaped so as to form the end bevels automatically when the blanks are bent, and the bending itself can be done in a jig or hammering form. This jig may be made of a piece of pipe of about 2″ outside diameter mounted in hardwood endplates. Also provide a holding fixture that will slide in the table groove of the bandsaw to assure that the slots for the end lugs are cut and spaced uniformly. A holding jig should also be made to line up the lugs and buckets for welding. On completion, balance the wheel by laying weld beads along the backs of any light buckets. Beads should be laid carefully and ground smooth.

Ball bearings may be employed, but are not necessary since the wheel turns at comparatively low speeds. If the builder prefers to use plain bearings, it will simplify machining the shaft, which should present a shoulder to the inside of the bearing so that the wheel may be positioned. If plain bearings are employed, babbitted linings are satisfactory, provided provision is made for proper lubrication.

One vital job that the foundation must do is hold the wheel and the nozzle in correct



Dramatic contrast in wheel sizes. Top, a 25-ton job designed for installation in a 30,000-hp. unit. It turns at 171 r.p.m. and has a 1,008' head. Below, a 12" wheel with reducer and gate-valve throttle.



relative positions. It should be placed on firm ground or piling so that it will not settle unevenly, and must, of course, take advantage of all the head possible. The penstock from the dam should have easy access to the nozzle, and the tail water easy escape to the stream. If possible use 4" or larger pipe for the penstock and lay it out to hold frictional losses to a minimum. The width of the foundation is such as to allow the water to fly clear of the buckets. The removable cover over the upper half of the wheel may fit more closely, since no water sprays from the buckets through this half of the revolution.

The foundation may be made of such materials as timbers in a framework, masonry, or concrete, so long as it fulfills the above requirements. The wheel and the machinery being driven may then be housed in any suitable, inexpensive shed.

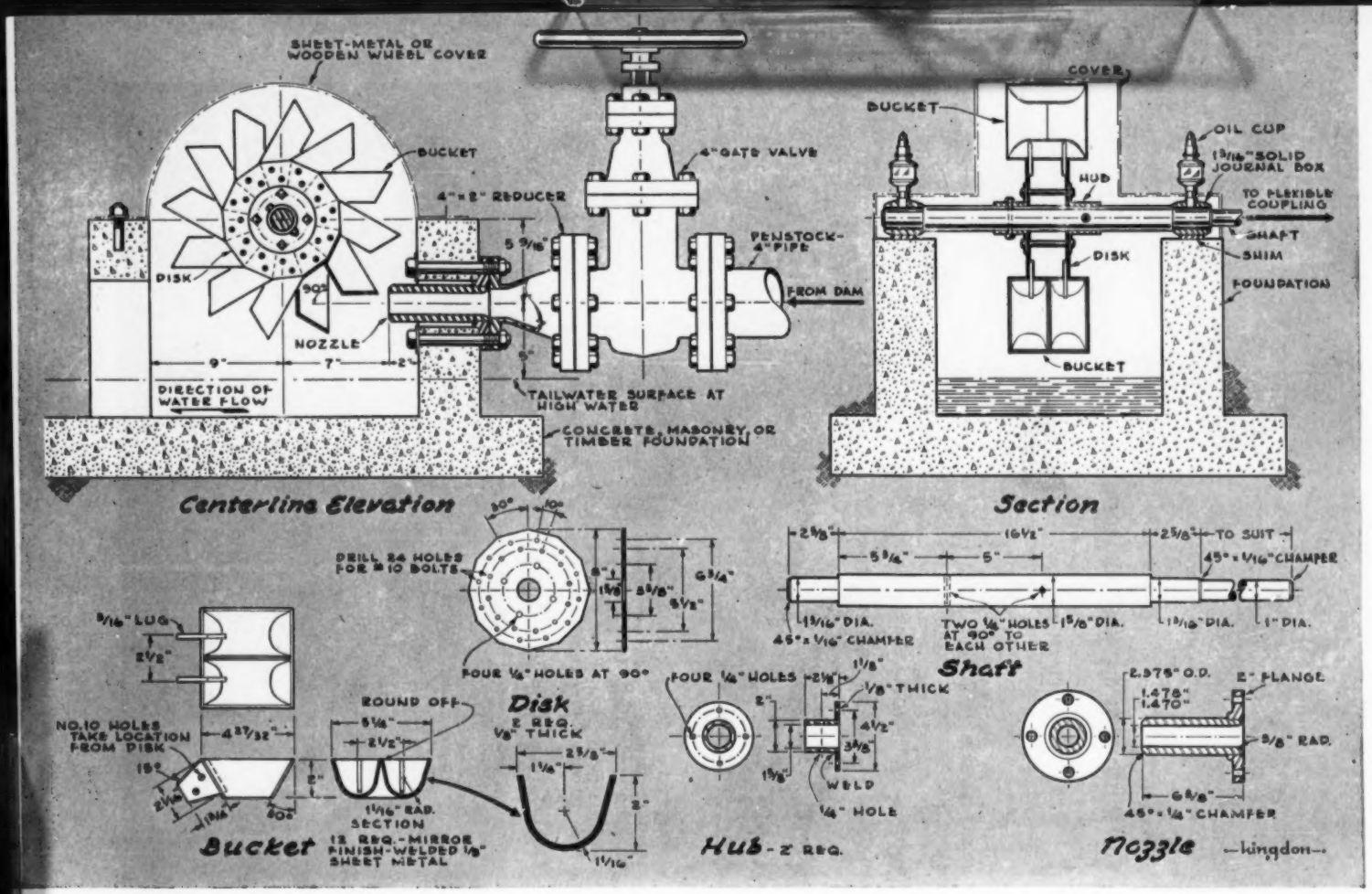
It's not wise to dispense with a gate valve, which is used to cut off or to throttle the water supply to the wheel. Since a gate valve cannot be operated rapidly, it is the best type, eliminating the risk of dangerous water hammer in the penstock. It is also well suited for throttling because fine adjustment is obtainable through the long operating screw. In throttling, the gate valve should be used together with a tachometer or revolution counter connected to the wheel shaft to secure the optimum speed and horsepower for the stream condition and load. Either fasten a tachometer permanently to the shaft, or keep a revolution counter handy in the wheel shed.

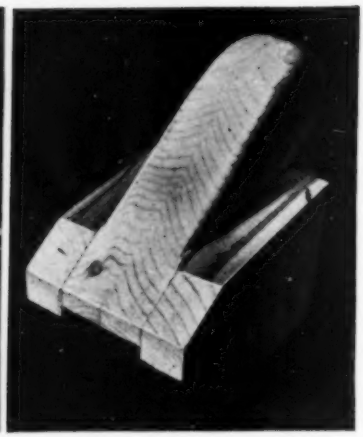
Generally the head and volume of water flowing to the wheel will remain constant, resulting in a constant output. If the machinery driven by the wheel has a level power demand there will be little need for constant adjustment of the valve.

The requisite piping, pipe fittings, steel sheet and rod, and bolts, nuts, and gaskets are available at building-supply houses or steel distributors. Machine screws, lock nuts, bearings, and the like may be purchased from good-sized hardware distributors or mail-order houses.

One final point to keep in mind in making your calculations: head is defined as the vertical distance between the water surface behind the dam and the tail-water surface at the wheel. For an impulse wheel, however, which cannot operate submerged, the available head is measured from headwater to the center line of the nozzle. As shown in the construction drawing, there is only 5" difference between the two definitions, but this can make some difference in output when working with the moderate heads for which this wheel is designed.

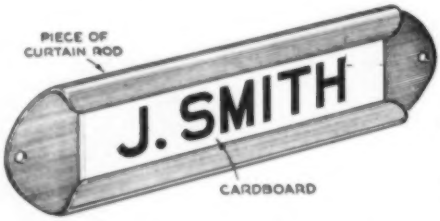
While many details can be altered, the reader should beware of any that will affect operating characteristics. Thus stainless-steel buckets and antifriction bearings would improve performance, involving only some extra work in building the wheel. Changes in the nozzle diameter, wheel radius, or effective head, however, should be undertaken only after careful consideration of the probable effect on performance. END


SHEET-METAL OR WOODEN WHEEL COVER
BUCKET
DISK
90°
NOZZLE
9"
7"
2"
DIRECTION OF WATER FLOW
4"×2" REDUCER
5 9/16"
4" GATE VALVE
PENSTOCK-4" PIPE
FROM DAM
5"
TAILWATER SURFACE AT HIGH WATER
CONCRETE, MASONRY, OR TIMBER FOUNDATION
Centerline Elevation
COVER
BUCKET
OIL CUP
1 3/16" SOLID JOURNAL BOX
HUB
TO FLEXIBLE COUPLING
SHAFT
SHIM
DISK
FOUNDATION
BUCKET
Section
30°
10°
DRILL 24 HOLES FOR #10 BOLTS
8"
1 1/8"
5 5/8"
6 3/4"
5 1/2"
FOUR 1/4" HOLES AT 90°
2 5/8"
16 1/2"
2 5/8"
TO SUIT
5 3/4"
5"
45°×1/16" CHAMFER
1 3/16" DIA.
45°×1/16" CHAMFER
TWO 1/4" HOLES AT 90° TO EACH OTHER
1 5/8" DIA.
1 3/16" DIA.
1" DIA.
Shaft
9/16" LUG
2 1/2"
NO.10 HOLES TAKE LOCATION FROM DISK
4 27/32"
15°
2 1/4"
1 DIA.
60°
2"
ROUND OFF
5 1/4"
2 1/2"
1 1/16" RAD.
SECTION
12 REQ.-MIRROR FINISH-WELDED 1/8" SHEET METAL
Bucket
Disk
2 REQ.
1/8" THICK
2 5/8"
1 1/4"
2"
1 1/16"
FOUR 1/4" HOLES
1 1/8"
2 1/8"
1/8" THICK
2"
4 1/2"
3 5/8"
1 5/8"
WELD
1/4" HOLE
Hub-2 REQ.
2.375" O.D.
1.478"
1.470"
2" FLANGE
5/8" RAD.
6 5/8"
45°×1/4" CHAMFER
Nozzle
—kingdon—



Pusher Block Rides Rip Fence for Sawing Small Pieces Safely

USING any old scrap as a pusher on the circular saw can cause trouble when small blocks or strips are cut. This pusher made of hardwood has a sure-grip handle, straddles the ripping fence, can't slip, and can be used for cuts on either side. A 45-deg. corner on the front of the cheeks holds the work down as it is pushed. Make the gadget by screwing two cheeks to a handle piece a trifle wider than the fence.—WILL THOMAS.



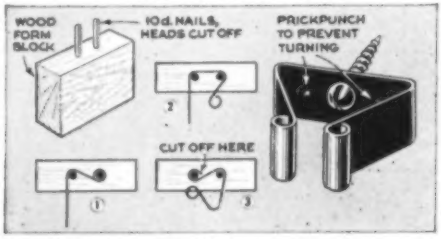
Curtain Rod Frames Name Plate

NAMES and direction cards mounted on doors or walls can be held neatly in short bits of flat curtain rod. Cut the ends round with tin snips, file smooth, and punch holes for small nails or screws.—FRANK SHORE.

Broken Blade Makes Small Saw

FITTED with a handle, a 6" length of broken ¼" bandsaw blade will make a useful keyhole saw. The detachable file handle shown has a thumbscrew that clamps the blade. An ordinary file handle could be used with a screw put through it and a hole punched in the blade to hold it firmly in place while sawing.—OSCAR HYLER.

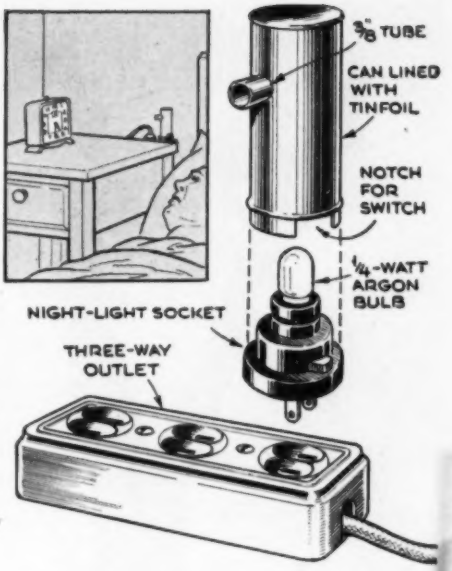
Wall Hangers Made from Baling Wire Will Hold Small Tools



The metal's natural spring grips tool handles.

SHORT lengths of ¾" strap metal of the kind used for baling and reinforcing packing cases can be bent into wall hangers for hammers, files, and the like. Make up several form blocks, spacing the nails according to the diameter of the tool handles; then bend the strap on the blocks to make brackets with curled ends. Punch for a mounting screw and, when the hangers are on the wall, prickpunch on both sides of the screw to keep them from turning.—ELMER H. BERRY.

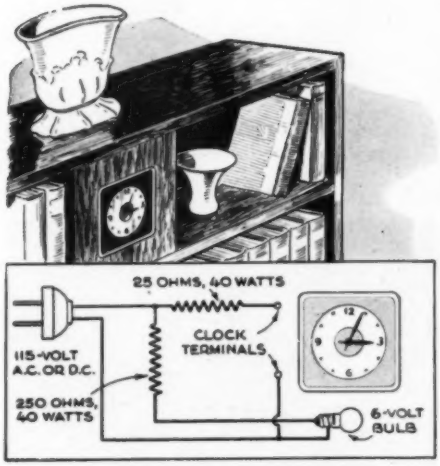
Argon Beam Lights Clock Dial



ULTRAVIOLET radiation that makes the figures on even an old luminous clock dial stand out clearly in the dark can be obtained from a tiny argon bulb. The purplish-blue ray is hardly visible.

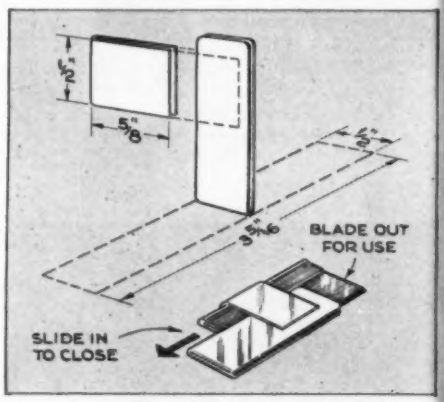
A ¼-watt argon lamp with a candelabra base can be obtained at radio supply stores; type AR-3 can be plugged directly into a household A.C. outlet. Screw it in a night-light socket having a switch in its base. If it is used in a three-outlet receptacle, an electric clock and a reading lamp can also be plugged in.

Any metal cylinder covered on one end can be made into a lamp house. A radio shield can will do, but one type of shaving-stick container just fits the night-light base. Make a hole opposite the bulb and solder in a tubular shield. Place the clock full in the beam. A 50,000-ohm, 1-watt resistor prolongs bulb life.—GEORGE P. PEARCE.



Dash Clock Wired for Home Use

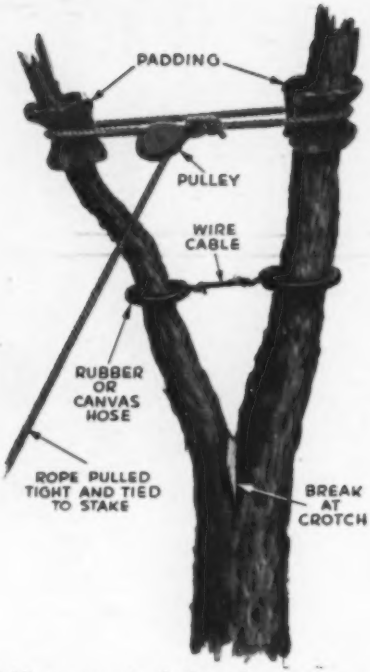
YOU can wire an automobile dashboard clock to run on 115-volt A.C. or D.C. as a handsome illuminated-dial house clock. Most car clocks are designed to operate on 6 volts, but since current flows only momentarily on the winding cycle, they can be connected to house current if a 25-ohm resistor is put in the circuit. If a 115-volt radio pilot bulb can be found, the 250-ohm lamp resistor can be omitted from the lamp circuit.—CRAIG C. MARTIN.



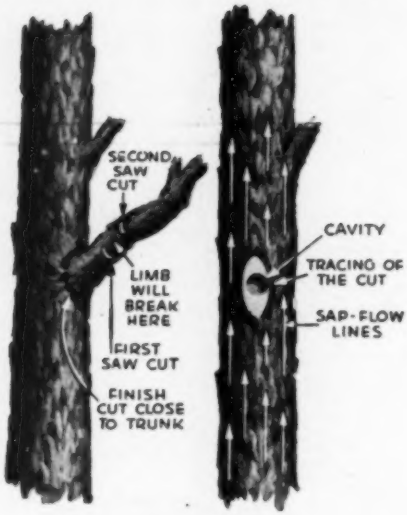
Holder Covers Edge of Blade

AMATEUR photographers and modelmakers find many uses for razor blades, but unguarded edges are a menace to careless fingers. A few minutes spent making this combination guard and holder for single-edge blades will be well spent. With it, a blade can be carried in the pocket.

Any reasonably stiff sheet metal or ½" wide band stock will serve. Fold a strip of the metal over at the center to cover a single-edge blade below the stiff back; then solder on a shorter folded strip to make a track for the back. This piece holds the blade rigid when it's in use.—W. F. HOLBROOK.



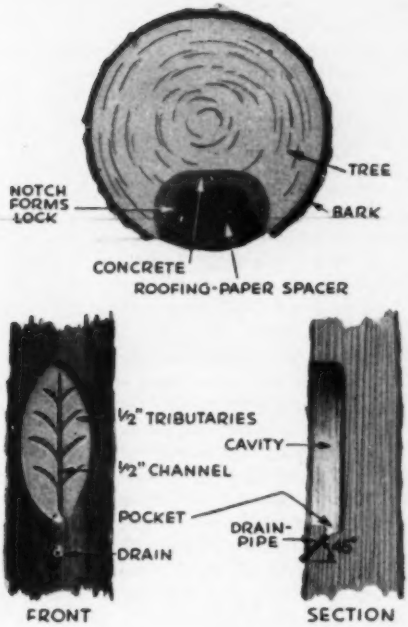
Cabling prevents further damage to a split crotch and gives the wound a chance to heal. Protect the bark under the wires.



In taking off a limb, make saw cuts in the order shown at left. Excavations should be long, not wide, to allow maximum sap flow.

Excavation is done with a mallet and sharp chisel. Rotting matter is removed down to clean wood, and chips are cleared out so air pockets won't form.

Bichloride of mercury disinfects the cavity, and the inside is then coated with waterproof paint. Wood between the bark and hole is shellacked.



At top, how a spacer fits into a concrete filling. Two views of a drainage system to take off slime flux behind a filling.

Concrete is put in a little at a time and spaced with roofing-paper sheets. The filling is slicked level with the wood, and the edges are beveled.

Save That Shade Tree

Simple surgery in time may preserve an asset to your property that would take years to replace.

By Earl Seidlinger

IT TAKES years to grow a tree and only a season of neglect to destroy one. With the best intentions, owners have done more to hasten the death of their trees by ignorant trimming and improper treatment than disease could do in a score of years. But there is no reason why an amateur, once he understands the problems and provided he acts in time, cannot arrest ordinary decay.

First aid in emergencies and proper seasonal trimming can do much to prevent the onset of decay. One of the most common accidents that can befall a tree, especially an elm, is splitting in the crotch. Cabling will prevent further damage and give the wound a chance to heal. Be sure to protect the bark under the wire.

When a limb is to be trimmed off, splitting can be avoided by a first cut on the underside a few inches nearer the trunk than the severing cut. Then saw the stump off close, but do not damage the bark. Coat the raw wood with asphalt paint or house paint, taking care not to get any on the bark. Nature will do the rest, and the bark will grow back as a callous.

If decay has already set in, more drastic steps will be required, but first look over the tree to see whether it warrants repair. If there is much dead bark on the trunk, if the upper branches are dying out, or if there is much fungus growth at the base, it may be best to get rid of the tree or to call in an expert tree surgeon.

When a tree appears healthy, it can usually be saved. Cavity repairs are best made from May through July, never before the

middle of April nor after the end of August. Drill test holes in the infection to determine the extent of decay, pulling out the drill at various depths to examine the cuttings. Trace a pointed elliptical cavity around the wound large enough to enable you to get out all the decay. A long cavity is less harmful than a wide one, as it permits maximum sap flow and promotes rapid healing. Smooth the bark at the edges with a sharp jackknife, and then shellac immediately to keep it from drying out—bark dries rapidly on hot days. Take care not to spring the bark from the tree or it will die.

Excavation is muscle work with a mallet and heavy chisel. Chip from the inside toward the edges and avoid injury to the bark. Make the back of the hole larger than the tracing so the concrete will wedge in firmly. A 7/16″ hole drilled at the top and bottom points of the tracing to the depth of the cavity or at least 2″, whichever is greater, makes excavation at the points easier. Leave a 1/16″ to ⅛″ ledge of wood between the bark and the excavation.

After all decay has been removed, smooth the inside walls with a sharp chisel to remove chips that might cause air pockets and promote further decay. Disinfect the cavity with a solution of 1 part bichloride of mercury to 1,000 parts alcohol. Then paint the inside with a good asphalt paint.

For a filler use 2 parts clean, sharp, white sand (no gravel) and 1 part Portland cement mixed thoroughly while dry, and add water and spade until damp. Don't get it too wet, or the filling will belly down from its own weight. Use one hand for an outside form, and put a little cement in at a time with the other hand or a trowel. Tamp toward the inside, adding more cement as needed.

If the cavity is more than 8″ long, horizontal spacers cut from three-ply roofing paper will be needed every 4″ or so. They are cut smaller than the cavity and notched for anchoring by the concrete. The usual practice is to place them so the concrete surface will be divided into squares, putting the first and last somewhat nearer the bottom and top of the cavity. Spacers allow for tree sway and for contraction and expansion in changing temperature.

When completed, the filling should extend slightly beyond the tree surface. It is slicked off and beveled around the tracing and at the spacers to prevent chipping.

Elms, hackberries, sugar maples, and some other trees have an abundance of sap that causes a slime flux behind a filling. They require a drainage system to allow the flux to drain out instead of working around the filling. Cut a vertical ½″ channel at the back of the cavity and furnish it with ½″ tributaries.

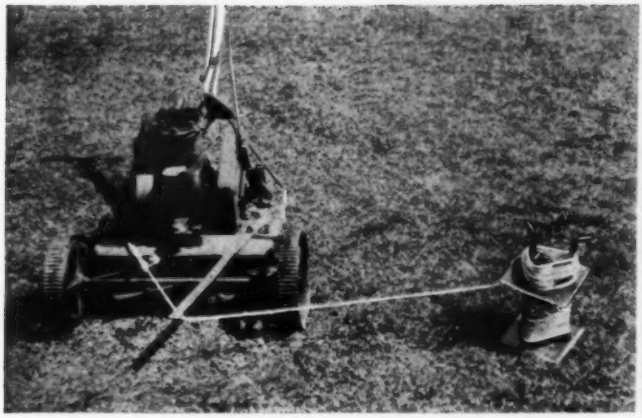
Lead the main channel into a pocket at the rear base of the cavity, and drill a drain hole to it at a 45-deg. angle. Pockets vary, according to the cavity, from golf-ball to tennis-ball size. A pipe is fitted into the drainage hole. All chips must be removed, no matter how small, or they may clog the pipe and spoil drainage. END

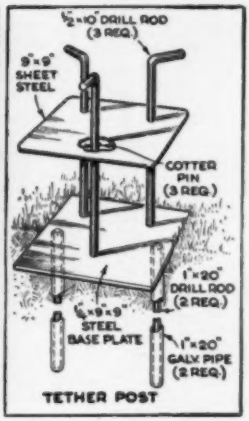
Turned Candlestick Is Made Without Resort to Lathe

EMBODYING the simplicity of a Colonial period turning, this candlestick will be a decorative centerpiece for a kitchen or dinette table. It is made from two lengths of dowel of different diameters and two turned holders that can be salvaged from the legs of a discarded chair. The circular base may be cut to a scribed line with a scroll saw and rasped and sanded smooth.

Cut the top of the center dowel on a slant to imitate the end of a burned candle, bore to take the cross dowel, and mount in a hole in the base. A tight fit in the holes and a little glue will make strong joints.

Stain or paint to match the kitchen color scheme.—R. J. DECRISTOFORO.





Tethered Power Mower Steers Itself While Cutting Your Lawn

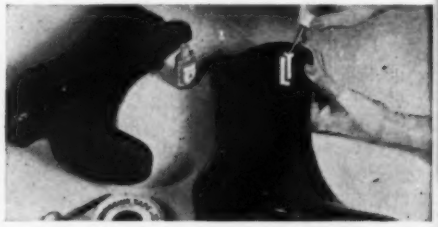
WEARY trudging behind a power mower can be eliminated if your lawn is fairly level and unobstructed by rocks or trees. Running at the end of a 75′ clothesline tether, the mower moves in a circular track of ever-decreasing diameter as the line winds itself up on a center post. Meanwhile you relax comfortably in the shade, ready to disconnect the clutch when the mower has worked its way down to a 4′ circle or if the blade should catch on a twig or pebble.

The center post consists of three steel rods welded or threaded to a base plate and spaced by a piece of sheet metal. A pair of rods beneath the plate fits into pipe sockets permanently located in the ground; with a big lawn several centers permit you to cut most of the area with a series of circles. The top rods are bent out to hold the surplus rope when a smaller circle is worked. The spacing of the rods depends on the size of the mower used and the amount of cutting overlap desired. For a 22″ mower and a 4″ overlap, the distance around the rods should be about 18″, which puts the rods about 3″ from a center point. If your mower is of a different size, calculate the desired circumference accordingly. Unless you make an extremely small center post, overlapping of the rope turns makes little difference in the effective circumference.

To guide the mower, bolt a sturdy steel bar to the front of the machine so that the steering pull is applied ahead of the center of turning. A snap clip at the end of the tether permits you to disconnect it quickly for trimming corners and centers with the mower guided by hand.—FORRIS B. CHICK.

Keeping Grease Off Burners

WHEN food is fried on a gas range, popping grease frequently spatters the burners not in use. Pie pans placed upside down over the unlit burners protect them and are easily cleaned.—BEATRICE E. REESE.



Tape Initials Mark Galoshes

INITIALS cut from adhesive tape and brushed with colored nail polish make attractive identification markers for galoshes. The initials are easily cut while the tape is stuck on waxed paper.—BENJAMIN NIELSEN.

HOME EXPERIMENTS

Tuned

ENERGY IN STEP. No matter how weak the force applied to an object, if it is repeated at intervals in step with the object's own rhythm of motion, it will bring about some amazing results. The phenomenon is called *resonance*. Familiar examples are a child's swing and notes on a piano that cause bric-a-brac to rattle. In each case weak pulsations are cumulative, adding up to a total force far greater than any single impulse. This can be shown by suspending a heavy book above a table and blowing gently on it at intervals timed to its period of swing. The book can be made to swing far enough by the force of successive puffs to upset another standing within its range.

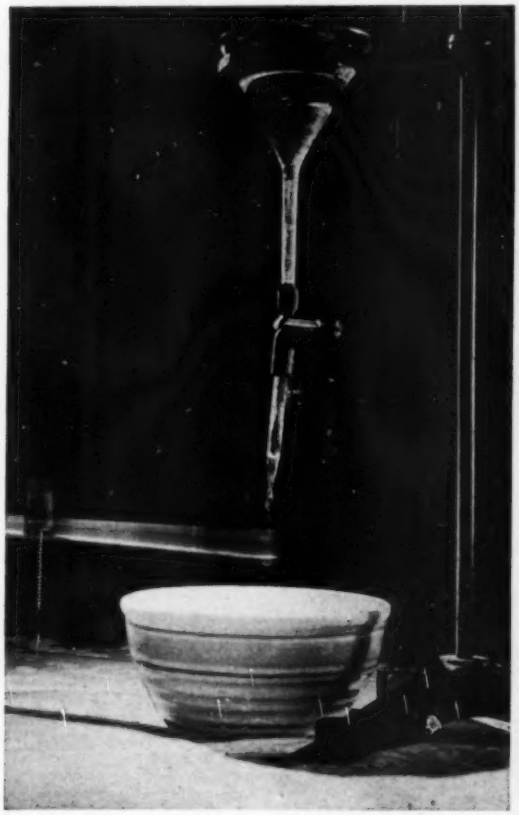
ORANGES SWING IN SYMPATHY. Suspend two oranges the same size on cords of equal length tied to a cord strung horizontally, and hang a third orange between them on a much shorter cord. Now start one of the end oranges swinging. As it swings, the other end orange will also begin to move in tune with its vibrations, increasing its swing as the first diminishes. Then, as the second begins to slow down, the first will again increase its swing. This keeps up until all the initial energy has been lost. The middle orange, having a different period of swing, is hardly affected.

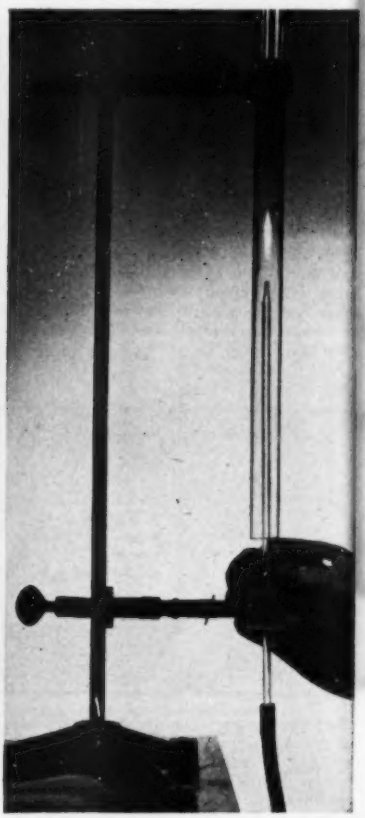
IN ONE BOTTLE, OUT ANOTHER. Waves of compression and rarefaction come to our ears as sound when air is set into vibration within a certain range of frequencies. If you blow across the mouth of an empty bottle to produce a strong, clear note, a person placing his ear near an identical bottle will hear the same note in it. This is because the air columns in both have the same frequency. The effect is made visual by hanging a light paper figure over the mouth of the second bottle. Then, when a good, strong note is sounded, the resonant vibrations will make the paper dance.

Vibrations Create Resonance

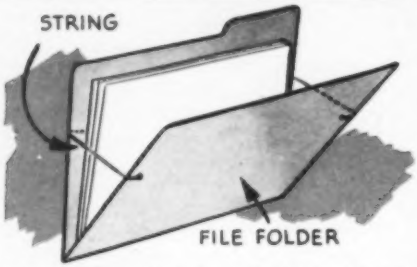
TUNED DRIP VIBRATES STICK. Some of the effects of mechanical resonance can be shown with the help of a yardstick and dripping water. Clamp one end of the stick in a vise or between heavy books, and drip water on the other end from the glass tube of a medicine dropper connected to a funnel by rubber tubing. Find the natural vibration period of the stick by pressing down and releasing the free end. Then tune the dripping water to this vibration by means of a screw clamp applied to the rubber tubing. If the rate of dripping is different from the natural period, the stick vibrates feebly; when the two are the same, each drop adds its push at just the right moment. A small object placed near the end of the stick will help in adjusting the timing. Vibrations are slowed down by moving the weight nearer the end.

FLAME PLAYS NOTE. One unusual means of starting up vibration is with a small gas flame. Support a 1″ diameter, 36″ long glass tube vertically by clamping it in a stand at its middle and introduce a 2″ flame from a jet drawn in a thin 12″ glass tube. Air in bottles, tubes, boxes, cans, and other enclosed spaces has a natural period of vibration, and when the flame has entered the tube to the correct distance, the rushing of gas from the nozzle will set the air in the tube into resonant vibration and produce a strong musical note. This note will continue at the same pitch until the flame is moved.

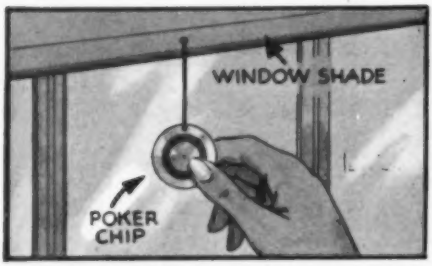




KEEPING the HOME SHIPSHAPE

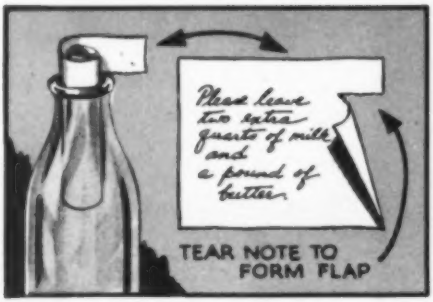


Do papers slip and slide in a file folder when you take it out of its place? Tying a string across each side as above will help keep the folder in shape and prevent its contents from falling out.

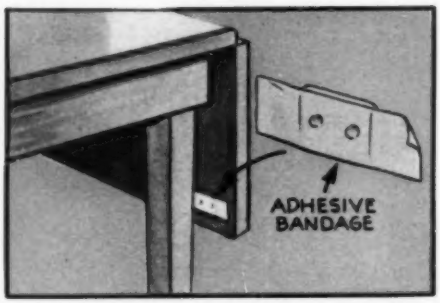


Poker chips make attractive, modern lamp-cord and shade pulls when they are drilled or punched for a string. Clamp chips between two pieces of wood and use a twist drill. The so-called noiseless or unbreakable chips, usually made of pressed cardboard, may be pierced with a red-hot nail.

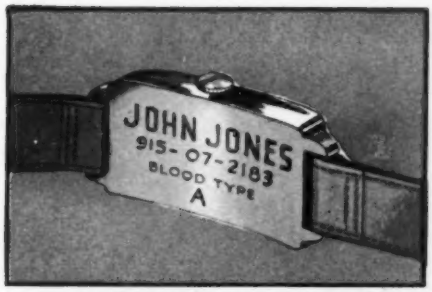
Paper shopping bags have a way of going to pieces in the rain. If you're caught in a downpour and want to keep your purchases all together and dry, tear a slot on the fold of a newspaper and slip it over the bag handles. This improvised cover will let rain drain off rather than into the bag.



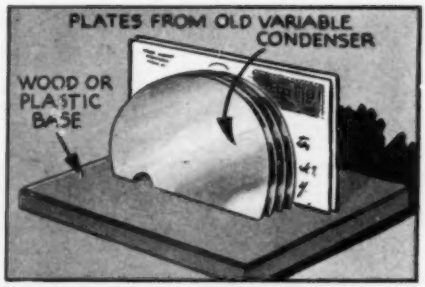
Here's a favor your milkman will appreciate both as a courtesy and as a timesaver. When leaving him a note, tear the paper about an inch from the top as shown. This forms a flap that projects beyond the lip of the glass and prevents the rolled-up note from dropping all the way inside the bottle.



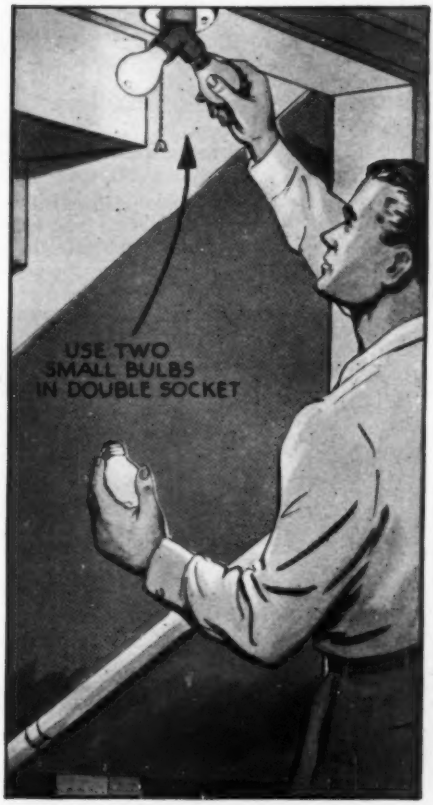
You can end the annoyance of having the drop leaf of a table rattle against the legs by sticking a small adhesive bandage at each point of contact. Color the bumpers to match the tone of the wood. They are not only inconspicuous, but can be removed easily and do not mar the finish of the furniture.



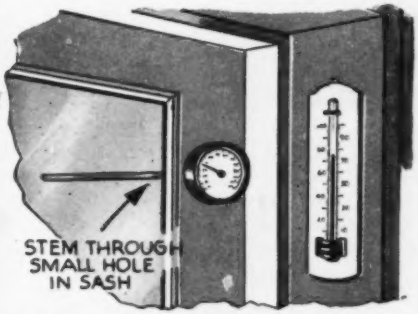
Just as soldiers' "dog tags" gave vital information in emergencies, your wrist watch can carry your name, social security number, and other data. This also identifies the watch in case of loss or theft. Remove the back and put the works in a dustfree place or under a glass while doing the engraving.



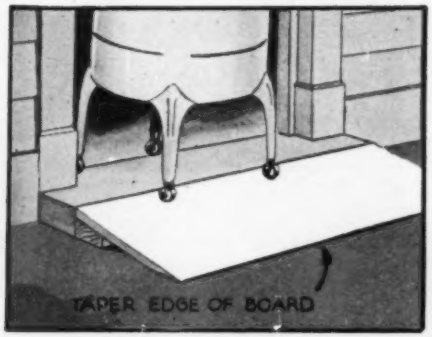
Plates from old variable condensers make fine letter holders for the modern desk. Polish the flat plates and mount them on a base of wood, metal or plastic as shown above. The outer plates can be engraved, given a trim line of black or colored enamel, or otherwise decorated to your taste.



Dark stairs or hallways are dangerous when light bulbs burn out. If you want to avoid being caught in the dark, insert double outlets in all sockets where a single bulb now provides the illumination. Two smaller bulbs will give an adequate amount of light but will not burn out at the same time.



Want to know the temperature outside the house as well as inside? Your stem-type photographic thermometer can be made to give outdoor readings if you drill a small hole in the sash and thrust the stem through the hole. Since the dial remains inside, the temperature can always be read easily.



Should a washing machine or other heavy appliance often be wheeled through a doorway, you can save wear and tear on your muscles as well as the doorsill by placing a wooden apron up against the sill as shown. Build it up to the thickness of the step and bevel the other edge flush to the floor.

TRACTOR PRESS BALES HAY. This press, made by John Deere, of Moline, Ill., picks up hay from the windrows and bales it automatically as a one-man job. A minimum of wire is used in the baling, and there are no short ends to fall to the ground and find their way into future bales. Windrows are picked up and fed directly into the bale case without a cross-conveyor. A steel tube serving as a hitch also houses the drive shaft.

MODERN PIGPEN OF STEEL. Fiber-glass insulation, an adjustable turret, and a removable door permit temperature control and ventilation in this structure to make the life of a hog the life of Riley. The hog house is made by the E. A. Strout Realty Agency and is light enough to haul by tractor or horse to new locations.

RAIN CAP PROTECTS EXHAUSTS. A die-cast aluminum fitting with a hinged cap keeps water, dirt, and birds from getting into the exhaust pipe of a tractor, power combine, or power hay baler. It fits almost all types of exhausts and mufflers up to 3⅛" diameter. H. M. Sheer Company, of Quincy, Ill., is the distributor.

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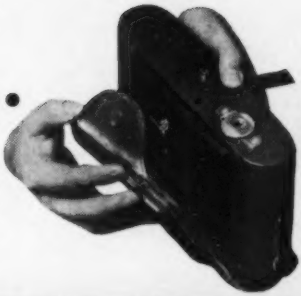

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Handsome Field Case of top-grain sole leather, with shoulder strap. Built-in ruggedness...quick accessibility for instant, easy shooting.

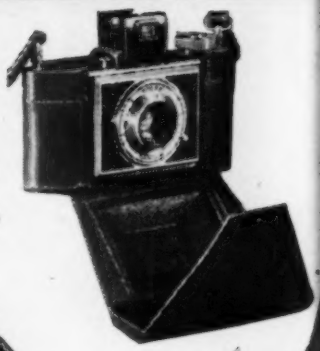
(Below)

FOR KODAK VIGILANT SIX-20...

Kodak Snapsack...russet sole leather with hand strap... illustrative of pouch-type case so popular for folding cameras. Also takes Kodak Monitor Six-20.

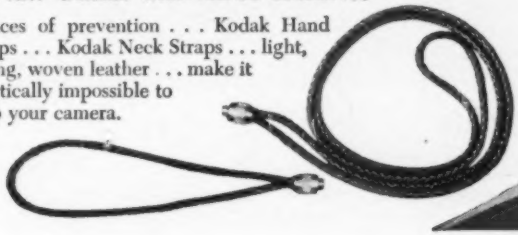
FOR YOUR BANTAM...

Handsome leather Field Case with neck strap... permits manipulation of all camera controls without removing from case... tripod socket in base. At your Kodak dealer's ... Eastman Kodak Company, Rochester 4, N. Y.



FOR ANY CAMERA WITH TRIPOD SOCKET...

Ounces of prevention . . . Kodak Hand Straps . . . Kodak Neck Straps . . . light, strong, woven leather . . . make it practically impossible to drop your camera.



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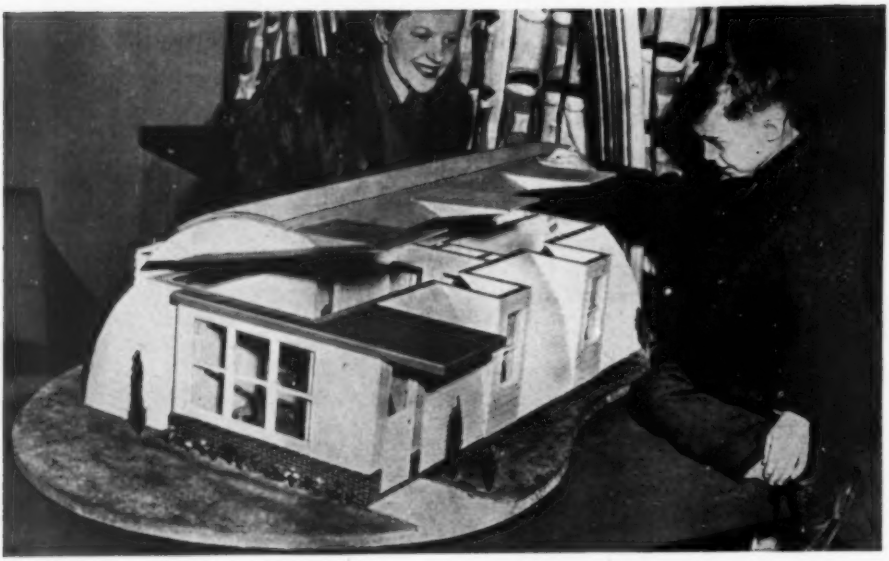
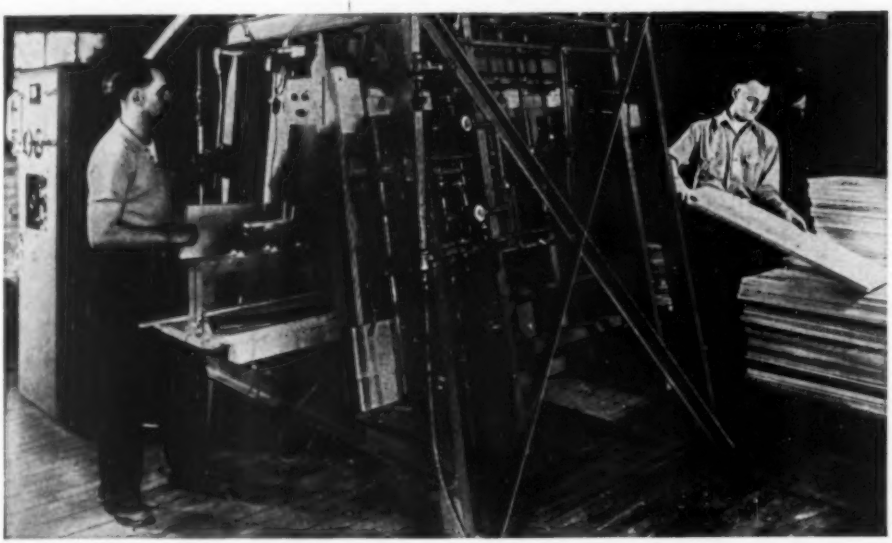


Quonset Sires House

DRESSED up and glamorized, the five-room bungalow illustrated by the model above is designed to cost only $4,000 to $6,000. Developed by the Great Lakes Steel Corp., which plans to produce basic units that can be completed by local contractors, its Quonsetlike arch-rib, Stran-Steel construction lowers cost and speeds assembly.



Heat Hardens Glue

IT TAKES less than a minute for this new wood-gluing press to cement boards together so tightly that no tongue-and-groove joint is required. Developed by the Raytheon Manufacturing Co., the press holds the pieces in a high-frequency electric field between two plates, while the heat thus generated sets the glue in 30 to 50 seconds.

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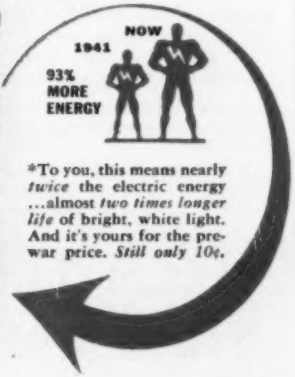

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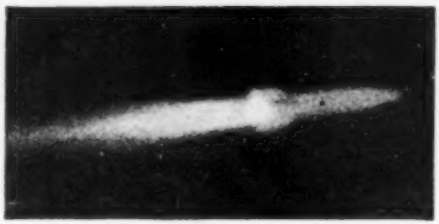


Mobile Unit Tracks Rockets

To WATCH the flight of long-range missiles, engineers of the Army Ballistic Research Laboratories have developed a turret-mounted telescope unit installed on a mobile gun carriage. Nicknamed "Little Bright Eyes," the unit has two 4½-inch telescopes: one visual; the other photographic, with a 35-mm. camera attached. Between them sits the tracker, using high-power binoculars. In center photo, above, the apparatus is shown awaiting a V-2's take-off; at top, it is swung skyward to follow the rocket's flight. The streak pictured in the bottom photo is a V-2 rocket, soaring 15 miles from the earth's surface, as seen by the photographic telescope in a test at White Sands, N. Mex.

Big boat . . .

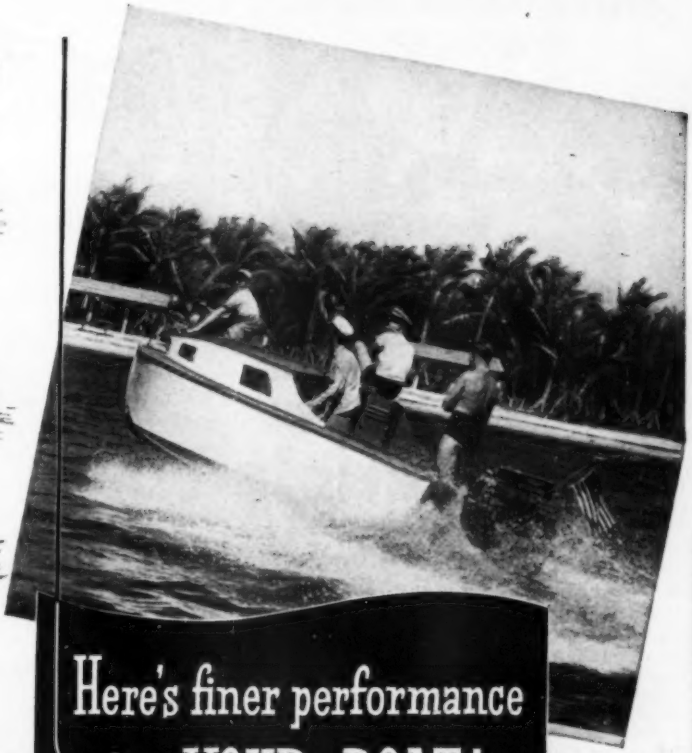
Little boat . . .

There's an

Evinrude

for every

type of boat!



Here's finer performance for YOUR BOAT!

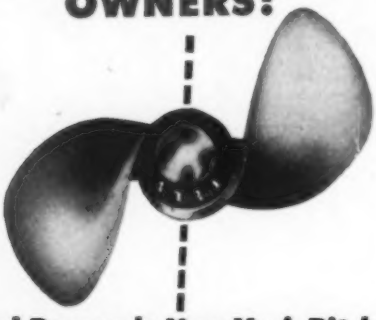
What a difference the *right motor makes* . . . in boat performance . . . in boating fun! It's easy to choose the *right* motor for any boat from Evinrude's *complete* line of 7 models . . . 2 handy "singles" . . . 2 smart twins . . . and 3 famed four-cylinder motors . . . the smoothest on the water! *Only Evinrude dealers* enjoy the extra sales-and-profit opportunities offered by a complete line of light motors . . . in addition to a complete line of four-cylinder models! EVINRUDE MOTORS, 5590 N. 27th Street, Milwaukee 9, Wisconsin.

In Canada: Evinrude Motors, Peterboro, Ontario.

EVINRUDE

FIRST IN OUTBOARDS — 38TH YEAR

OUTBOARD MOTOR OWNERS!



Paul Bunyan's New Vari-Pitch PROPELLER GIVES YOU

4 speeds!

1. Low **3. High**
2. Intermediate **4. Overdrive**

all from one propeller permanently installed on your motor!

Now you can troll as slowly as you wish, without plates or special devices. Merely set the pitch of a Paul Bunyan Vari-Pitch propeller at low and you barely move. To speed up, change the pitch, just as you would shift gears in a car. For extra fast speed, use pitch 2, 3 or 4, depending on load. Adjustment is simple, self-locking, fool proof, can't come loose.

Now, for the first time, sportsmen can have *four motors in one*, by installing the Vari-Pitch propeller, which becomes a permanent part of your motor.

NOW AVAILABLE for the following motors:

TYPE "D" Johnson 5 H.P. 1941 to present.
TYPE "DZ" Johnson 4.5 H.P. up to 1940 inclusive.
TYPE "C" Evinrude Zephyr 5.5 H.P. All years.
Above Models $10.00. On these adjusting ring is in front of propeller as illustrated.
TYPE "A" For Champion singles 1938 serial number 3000 and over, to and including 1942. Also Firestone 1946 10-A-4 and 10-A-1A.
TYPE "B" Champion singles up to 1938 serial number 3000. (Note: some of the older motors have replacement lower units which take type "A" propellers.)
TYPE "F" Champion singles 1946 to present.
Above Models $8.00. On these adjusting ring is inside hub.

NOTE: If you have difficulty obtaining Paul Bunyan Vari-Pitch propeller, write us, giving type desired. Enclose check or money order and your propeller will be sent to you through one of our many dealers.

PAUL BUNYAN BAIT CO.
Department PPS77
Minneapolis 5, Minn.

Fishermen's Tools Clip Vines

THE high-grade steel, cadmium-plated pincers and pliers pictured above were originally designed for fishermen, but have been adopted by gardeners for pruning shrubs and vines. The self-opening tools can also be used for mechanical jobs. The Bartelt Engineering Co., Rockford, Ill., is the maker.

Water Jet Drives Boat

A PROPELLERLESS boat, powered by a high-velocity water jet and capable of maneuvers not possible in conventional craft, is a new experiment of the Continental Motors Corp. Designed to turn in its own length, move sideways and astern, and operate in shallow and weed-infested waters, its method of propulsion is known as "hydropulsion." Similar in principle to that of an airplane jet engine, it utilizes the pushing force of a solid stream of water ejected under hydraulic pressure.

Dependable

CHAMPION

AMERICA'S FAVORITE SPARK PLUG

The Champion 100-Mile-an-Hour Club, the "world's most exclusive club," is composed of those race drivers who have driven the full 500 miles in the Indianapolis Race, at an average speed of 100 m.p.h., *without* relief. Of all the race drivers who have competed in this international speed classic, only 35 have achieved the distinction of becoming members and are entitled to wear the club emblem. 32 of these 35 qualified for membership using dependable Champion Spark Plugs.

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*Deceased

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HAND AND POWER GRINDERS

DEPENDABLE

Here's a name in grinders that has been famous for 50 years—Luther Grinders are manufactured to the most exact specifications—You will find a dependable Luther hand or power grinder for your purpose.

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Fill Holes, cracks, dents, gouges

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- STAY IN!

Duratite Wood Dough will fill rough or irregular cavities in wood, metal, plastic or plaster in *one* application. (Duratite Surfacing Putty for shallow cavities). Can be sawed, cut, milled, sanded; are waterproof, fire resistant. Seven wood colors, in tubes or cans, at Hardware and Paint stores. Made by Manufacturers of famous Arrowhead Cement.

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or Webb Company • Dept. S • Norcross, Georgia

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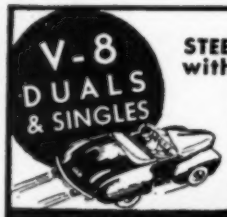

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SINGLES, Chev, V-8, Plymouth, Steels $5.50, Aluminum $6.50. Chry., Olds., Buicks, etc., Steels $7.50, Aluminum $8.50. V-8 and MERCURY DUALS, Steel $17.50, Aluminum $20.00. Aluminums are guaranteed for life of your car.

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A.C.: 350 to 35,000 watts in all standard voltages and frequencies. D.C.: 600 to 10,000 watts, 115 and 230 volts. BATTERY CHARGERS: 500 to 3,500 watts; 6, 12, 24, 32 volts.

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G-E EXPOSURE METER
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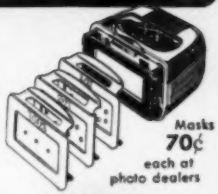
These 3 new masks snap on the G-E meter in place of hood to let you read INCIDENT LIGHT (light on subject) the *professional* way. Gives better quality in color, stills, movies. With hood on, the meter provides extreme accuracy for reflected light. Easy to use. Many other advantages. Get a G-E meter and get better vacation pictures. *General Electric, Schenectady 5, N. Y.*



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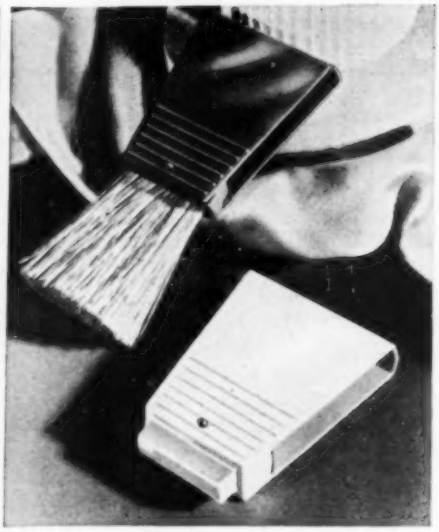
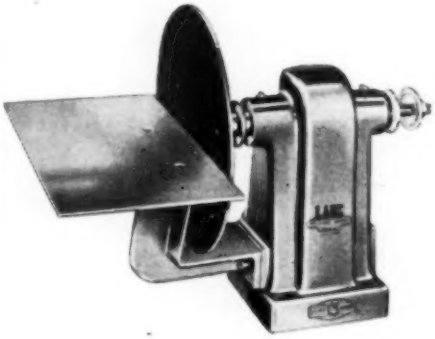
PLOMB *Streamlined* TOOLS



Brush Slips into Handle-Case

A WHISK-BROOM travel brush, mounted at the end of a plastic combination handle and case, folds into the case when not in use and can be quickly opened when needed. The Kippy-Kit Company, of Circleville, Ohio, manufactures it.



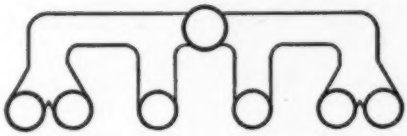
Sander Does Heavy Jobs

FOR heavy-duty work at home or in a shop, this disk sander and polishing head combination accommodates a variety of accessories. Made by the Lake Manufacturing & Engineering Co., of Syracuse, N. Y., the device can be driven from below or behind by a ½-inch V-belt. Two arbor V-pulleys provide speed changes and shaft adjustment.

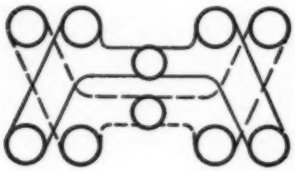
Why Ford engines don't overeat!

Balanced carburetion feeds every cylinder EVENLY

● Whether you own the Ford Six or the V-8, you're sure to get balanced downdraft carburetion. You're sure that every cylinder is properly fed . . . and economically, too!



In the SIX the downdraft carburetor serves the cylinders through a unique four-port manifold with dual leads. Two leads serve the two center cylinders, the others serve the end pairs. As in the V-8, this results in even feeding.



In the Ford V-8 engine, the dual carburetor feeds the cylinders through a duplex manifold. Each manifold serves four cylinders whose place in the firing sequence prevents simultaneous suction by any two cylinders.

In both SIX and V-8, you get greater economy from Ford's accelerating pump which sends extra fuel into the carburetor when the engine needs extra power, but saves this fuel in normal driving. And in cold weather Ford's new Automatic Manifold Heat Control routes warm exhaust heat past the carburetor for quick warm-up, then back through normal channels.

These and many other features put FORD OUT FRONT for fuel efficiency.

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Do as professional repairmen do—seal small cracks and porous holes in metal castings with Smooth-On No. 1 Iron Cement.

You simply mix Smooth-On with water and force the mixture into the opening. It hardens like metal and stays tight, because Smooth-On expands slightly as it sets.

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Keep Smooth-On handy for emergency repairs. Buy it in economical 1¾-oz. or 7-oz. size at your hardware store. If they haven't it there, write us.

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20	3.25	4.25	2.75	3.75	1/2 5/8 3/4
24	3.50	5.00	3.00	4.25	1/2 5/8 3/4
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Ideal for hard and soft soldering. Will heat quickly; solder will flow freely and smoothly. No compressed air required. Nothing to pump. Self-adjusting. Safe. Economical. Can be used for annealing small parts and bending metal parts. Generates a heat of 1700° Fahrenheit. Simply connect to any illuminating (manufactured) gas jet with a rubber hose and operate. Tornado Torch No. 119 comes with three (3) tips, (1/8", 1/4", 3/8" blast).

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To order above wheels write number wheels wanted in space provided, tear out and mail this ad with check or money order and your name and address. If other sizes are wanted write for FREE LIST.
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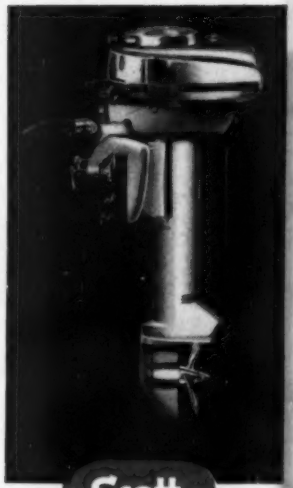
Performance!

Put a Scott-Atwater on the back of your favorite craft for a trial run. See how it flashes into action on the first pull of the starter! Speed across the lake—watch your boat race through the waves! Then idle down to a creep—your boat barely moves, yet the Scott-Atwater purrs smoothly on.

This sensational performance is the result of experienced, progressive engineering. For example—Scott-Atwater's *multiple feather-valve* intake system. Scott-Atwater feather valves *automatically change timing* to maintain a full fuel charge at *all* speeds. This guarantees easy starting, slow trolling and full top speed.

Send coupon today for the new fishing book, "How to Catch More Fish."



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To shine it bright

Removes dull traffic film—restores the original color and lustre—quickly, easily and safely.

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No 7 POLISH

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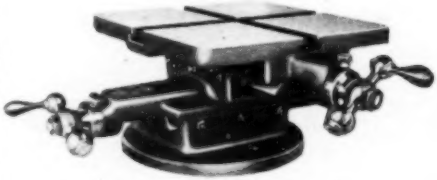
TEN times brighter than the ordinary 20-watt airplane reading lamp, a new type 2⅝ inches long (inset), formerly used in gunsights, has been announced by General Electric's Lamp Dept., of Cleveland, Ohio. The lamp is recessed into a wall or ceiling to avoid glare.



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A SMALL, two-way micrometer-feed sliding table for light milling in the drill press, as well as for precision hole location, is manufactured by Leo G. Brown Engineering Co., of Los Angeles. The table, easily mounted on a drill press, is 7½ inches square and is fitted for one-inch T-bolt heads. Both feeds have a travel of five inches.

AIRPLANE GENERATOR

25 AMP.

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1 INCH BETWEEN WASHER AND COLLAR

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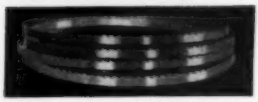

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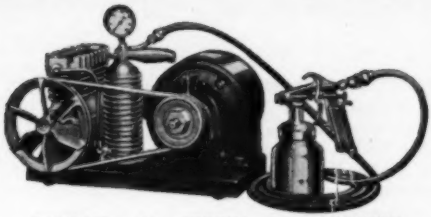

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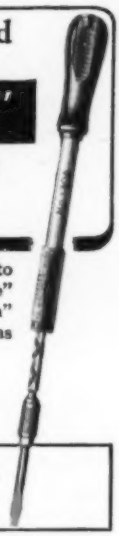

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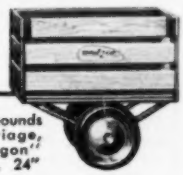

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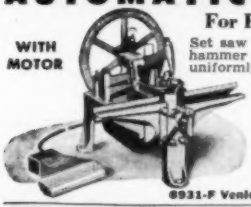

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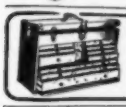

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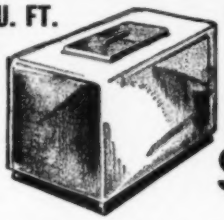

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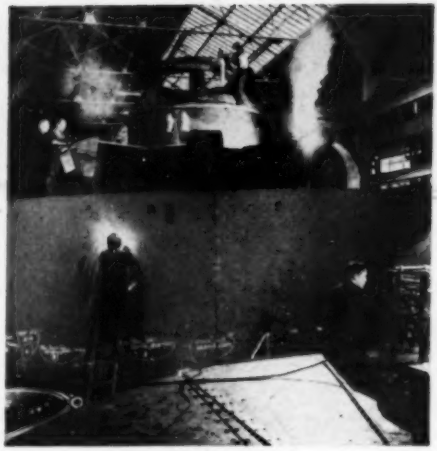

Last Generator for Shasta

THE last of five 75,000-kilowatt generators for the Shasta Dam hydroelectric plant in the Sacramento River Valley is shown under construction at the General Electric works at Schenectady, N. Y. When installed, the five generators will produce enough electricity to light more than 10,000,000 household lamps.

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DESIGNED to seal 35-mm. double- or single-frame transparencies in only six seconds, the Thermo-Sealer, a product of the Albert Specialty Co., of Chicago, protects the slides with hermetically sealed covers of glass and plastic. Operating on electricity, it automatically aligns the glass plates and maintains correct pressure and heat.

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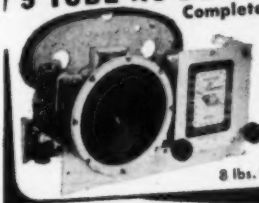

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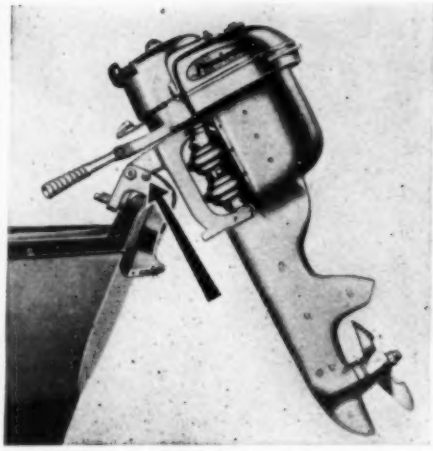
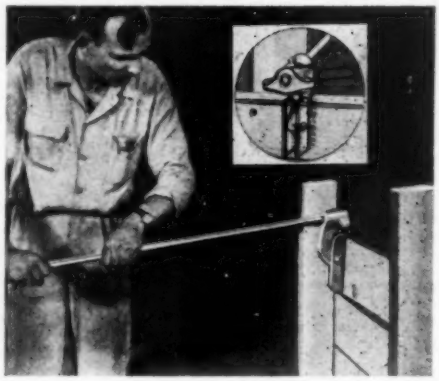


Outboard Spares Its Propeller

AN OUTBOARD motor equipped with a device that automatically disengages the propeller when an obstruction is encountered is produced by the Metal Products Corp., of Milwaukee. Smaller and lighter than prewar models of similar horsepower, it also features fingertip controls, dual carburetion, and (arrow) a tilt-up securing lock.



Lever Tool Salvages Lumber

THE Bord-Pri, a new tool for the reclamation of old lumber in razing jobs, is designed to facilitate the removal of sheathing, siding, flooring and other woodwork. Manufactured by the Maco Corp., of Huntington, Ind., the tool exerts an equal distribution of pressure against the entire end of the board to be removed, thereby minimizing splits and cracks.

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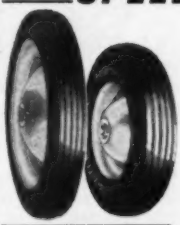

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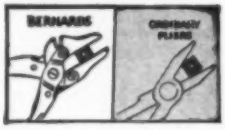

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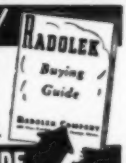

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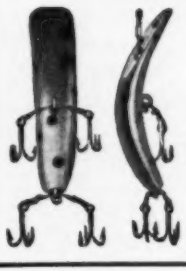

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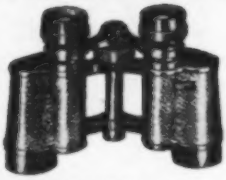

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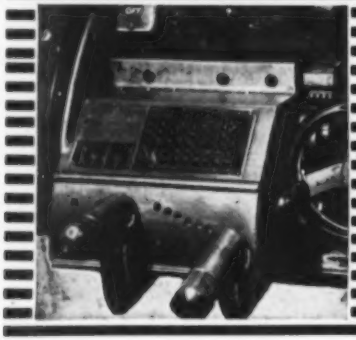

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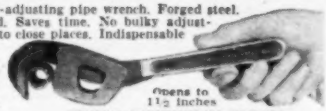

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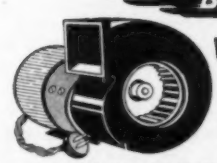

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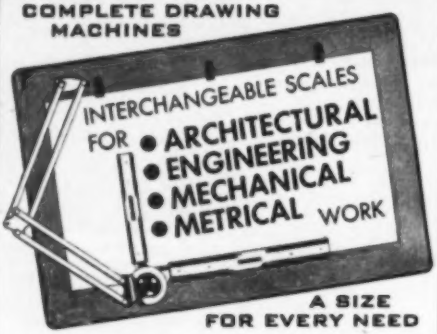

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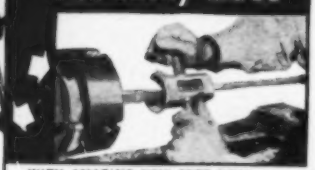

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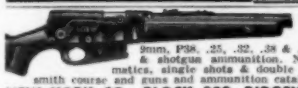

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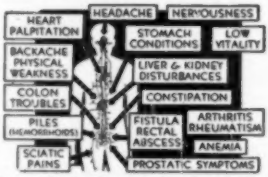

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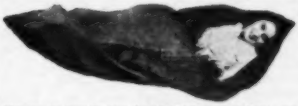

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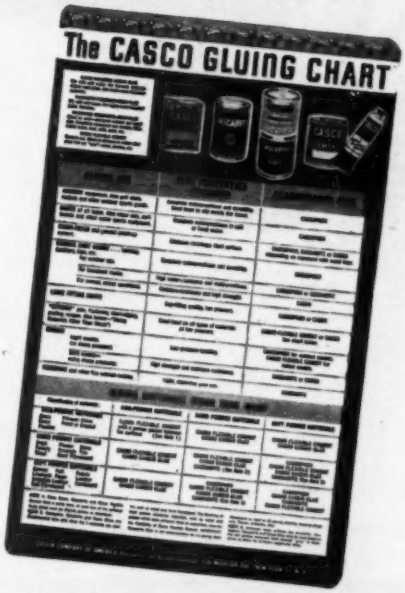

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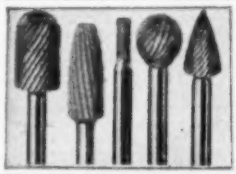

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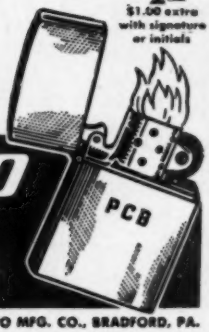

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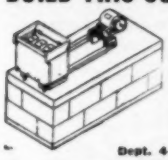

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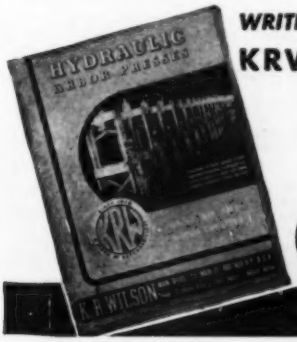

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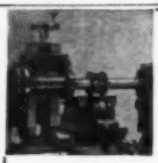

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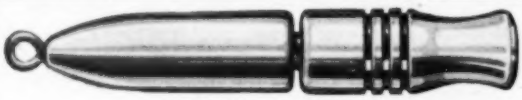

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TO: Reader
FROM: Editor

"Technology—An American Export"

PSM's editors and friends celebrated the magazine's 75th anniversary at a birthday dinner on May 1 in the Waldorf Astoria. Robert P. Russell, president of Standard Oil Development Company, was a speaker. His subject was "Technology—An American Export." We think you will find these excerpts interesting.

As a nation we are blessed with the fortunate combination of natural resources and the requisite technical skills to use them. This combination exists in few other countries. We attempt to help less fortunate nations through the large-scale export of goods, but I am convinced that to provide permanent aid we must add technological skill and knowledge to our material exports. Goods alone offer only temporary relief.

One field in which we are well equipped to do this is in agriculture and food production. Most of the world is perilously short of food. In many countries there are such shortages that the national diet is below the minimum level required to maintain the energy of the people. If everyone is to have enough to eat, the land must be made to yield the same or more food but with less and less labor for planting, cultivating, and harvesting.

Here is a situation in which our United States research and development organizations can render important service. During recent years several research organizations have devised remarkable new techniques for utilizing hydrocarbons for weed control—among the most effective being sprays of petroleum distillates of the type often used in dry cleaning. Not only can they be used to kill weeds without harming the crops, but they can be sprayed on the ground after seeds are planted but before they sprout for the destruction of weed seed. In this way, weed-free soil can be maintained without cultivation through an entire season (PSM, July '46, p. 101.)

Robert P. Russell

Weed control is *the* most important Central and Latin American agricultural problem, since climatic and soil conditions make weed growth amazingly rapid. In fact, weed control occupies the major part of the energies of farm labor throughout this enormous territory.

Recently I was privileged to see what was probably the first major field trial of some new synthetic weed killers when they were applied to a major Latin American crop—rice. The difference was spectacular.

Other food crops, too, could benefit greatly from the attention of U. S. technical groups. For example, a world shortage of chocolate and cocoa exists. Between the time the cacao pod is whacked off the tree with a machete and the time the finished bean is ready for shipment a third of the crop is often lost. The problem of cacao harvesting, cleaning and drying has, in fact, recently received the attention of a small group of fertile-minded, enterprising United States development engineers. Within a few months they succeeded in greatly shortening the time between the harvesting of the cacao pod and shipment of the finished bean, sharply cutting crop losses and improving quality.

We could help decisively to improve conditions throughout a vast area of our hemisphere by making new products such as these synthetic weed killers available to our neighbors and, more important, by sending to them the trained technical people needed for working out proper applications under varying local growth conditions. Our people could also apply locally their engineering knowledge to problems of food processing.

By giving a helpful technical hand, we can prove to all the world that our system of democratic, competitive enterprise not only works, but that it can contribute more to the well-being of people than any other system thus far devised. The lending of money and exporting of goods are not enough. In our own enlightened national self-interest we must study the economic problems of our neighbors and assist actively in solving them.

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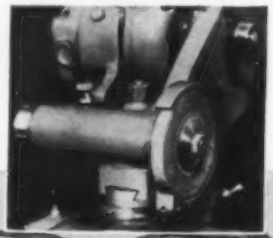

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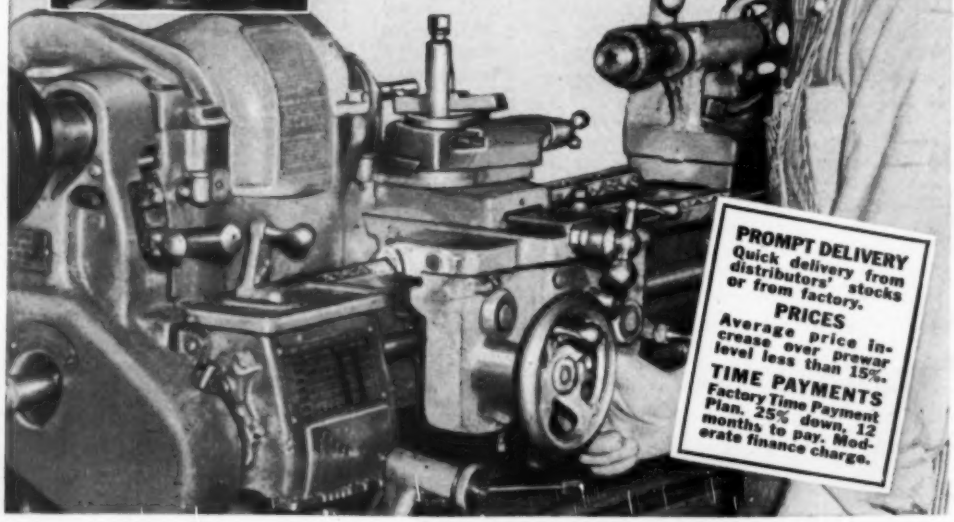

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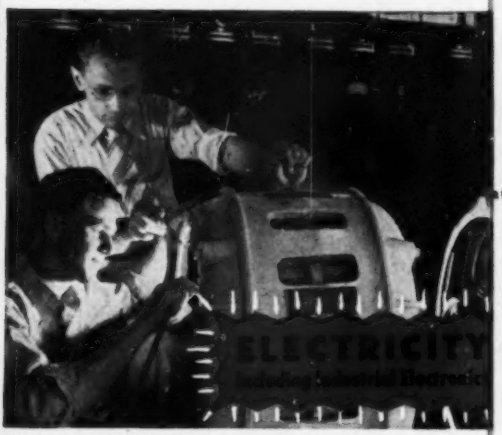

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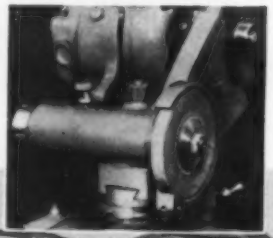

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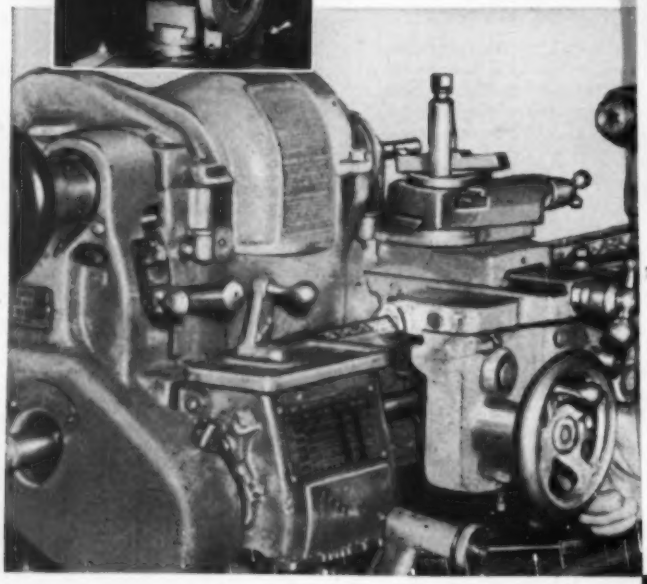

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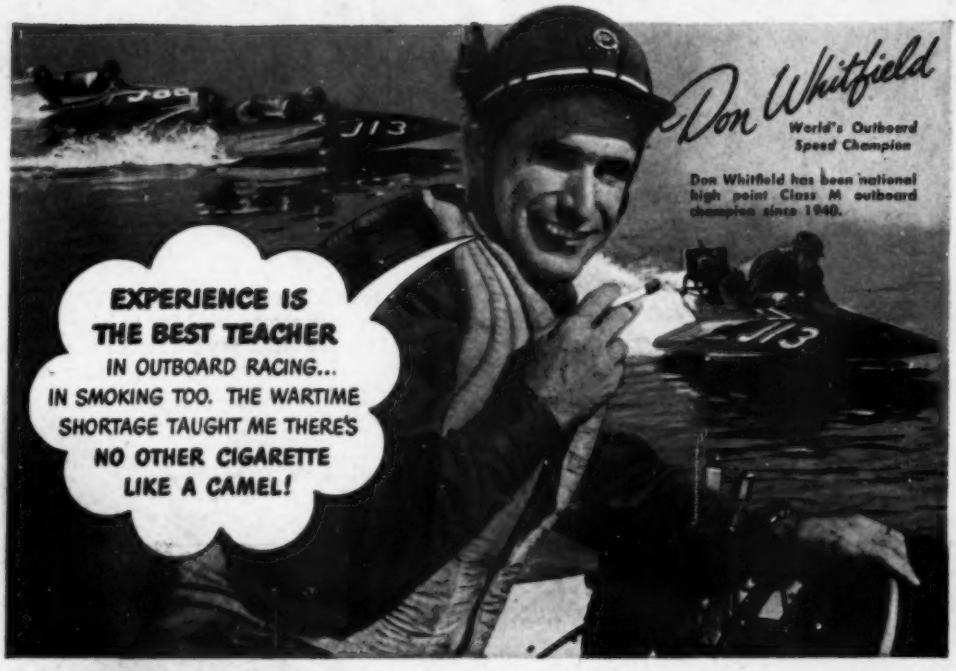

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